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## B838: The Amphibians and Reptiles of Maine

Malcolm L. Hunter Jr.

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Jane Arbuckle

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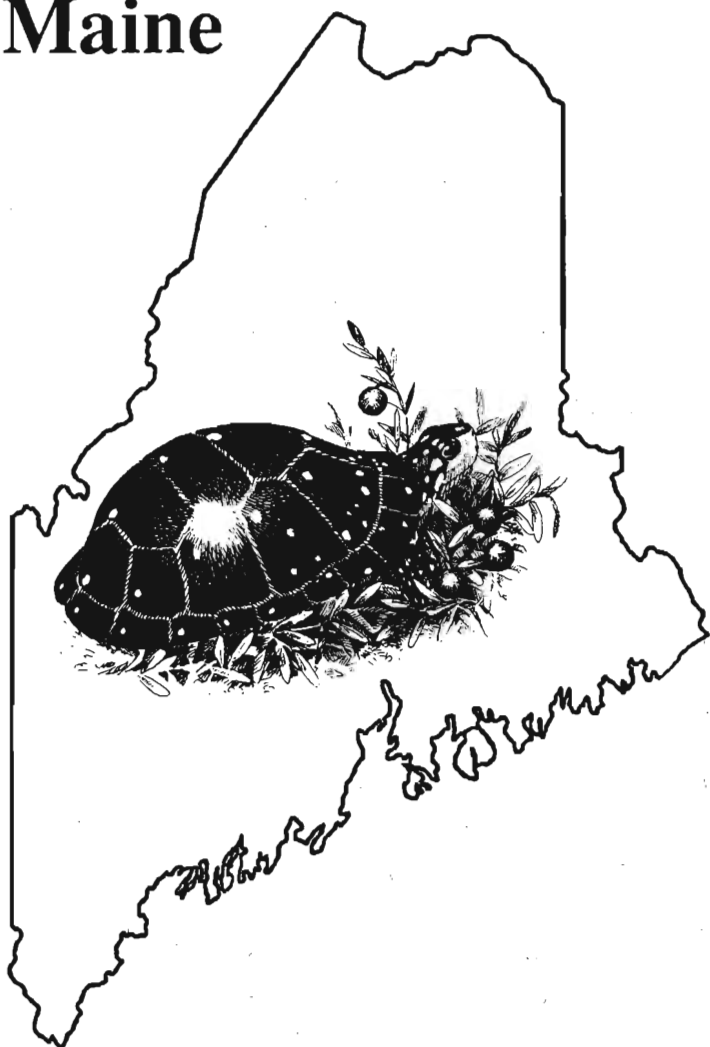
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### Recommended Citation

Hunter Jr., M.L., J. Albright, and J. Arbuckle, eds. 1992. The Amphibians and Reptiles of Maine. Maine Agricultural Experiment Station Bulletin 838.

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# The Amphibians and Reptiles of Maine



# The Amphibians and Reptiles of Maine

edited by

Malcolm L. Hunter, Jr.

John Albright

Jane Arbuckle

Illustrated by Mark McCollough

## THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT

In collaboration with the

Endangered and Nongame Wildlife Fund  
Maine Department of Inland Fisheries and Wildlife

Maine Audubon Society

Maine Natural Heritage Program  
Department of Economic and Community Development

The Nature Conservancy, Maine Chapter

Wildlife Department  
University of Maine



**Bulletin 838**

**July 1992**

MAINE AGRICULTURAL EXPERIMENT STATION  
UNIVERSITY OF MAINE  
ORONO ME 04469

Available from:

Maine Department of Inland Fisheries and Wildlife  
State House Station 41  
Augusta Maine 04333

Proceeds from the sale of this book will be used for reptile and amphibian conservation work in Maine.

Suggested citation:

Hunter, M.L., J. Albright, and J. Arbuckle (editors). 1992.  
The amphibians and reptiles of Maine. Maine  
Agricultural Experiment Station Bulletin 838.  
188pp.

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## PREFACE

These foul and loathsome animals are abhorrent because of their cold body, pale color, cartilaginous skeleton, filthy skin, fierce aspect, calculating eye, offensive voice, squalid habitation, and terrible venom; and so their Creator has not exerted his powers to make many of them.

This statement by Carl Linnaeus, perhaps the most famous biologist of the 18th century, may seem long on strong adjectives and short on facts, but it clearly shows that amphibians and reptiles were not well regarded in Linnaeus' day. How much has changed in 200 years? Despite the popularity of Kermit the Frog and the Teenage Mutant Ninja Turtles, most people harbor little affection for these creatures. Even the collective nickname currently used by naturalists—"herps," from herpetology—seems to echo the foulness suggested by Linnaeus.

Ignorance breeds contempt, which breeds further ignorance. We know little about herps because we find them contemptible; it is easy to dismiss them as contemptible because they are often nocturnal or subterranean, thus we rarely see them. It was ignorance about the herps of Maine that, in 1984, catalyzed the efforts that ultimately produced this book.

That year Maine's biologists were faced with decisions about which of Maine's vertebrate animals should be listed as endangered or threatened under the state's new Endangered Species Act. It was obvious that there was not enough information about Maine's herps to make informed decisions so John Albright, Jane Arbuckle, and I decided to initiate the Maine Amphibian and Reptile Atlas Project, or MARAP, with the support of our organizations (the Natural Heritage Program of The Nature Conservancy, the Maine Audubon Society, and the University of Maine Wildlife Department, respectively) and the assistance of the Endangered and Nongame Wildlife Fund of the Maine Department of Inland Fisheries and Wildlife. Patterned after the recently completed Maine Breeding Bird Atlas Project, this effort would use volunteers distributed throughout the state to document the distribution of herps over a five-year span.

The project was successful. Over 250 people responded to our call for volunteers, received an instruction manual, "A preliminary guide to finding and identifying the amphibians and reptiles of Maine," and were soon mailing in cards recording where and when they found herps. The first two years were the most productive, and we were able to make some reasonable decisions about which species should be listed as endangered or threatened. In the last three years of the project the number of record cards submitted declined, probably because volunteers stopped finding new herps in their area, but we continued to receive hundreds of cards each year through 1989.

When we began the project we knew that our objective was to write a book about Maine herps and thus spread interest in herps beyond the ranks

of MARAP volunteers. As MARAP came to an end we modified our idea; we decided to capitalize on the expertise, energy, and enthusiasm of our volunteers by asking *them* to write the book. We found authors for each species; gave them a general outline, literature citations, and some key papers; and asked them to write an account that fellow naturalists would find interesting and informative. We believe they have succeeded and are confident that this book will foster a greater appreciation for amphibians and reptiles among Maine's naturalists and students. We will know the effort was worthwhile if future generations read Linnaeus' description as a quaint relict with little relevance to their personal values.

—M.L.H.

### Acknowledgments

The key to MARAP's success was a large group of enthusiastic participants:

Eileen Adams	Peter Cannell	D. Diefenbach
Enoch Albert	J. Chapman	Sara Dinyari
John Albright	C. A. Chase	Gary Donovan
Simon Alexander	Edie Chentey	Phil Downes
Brad Allen	Allison Childs	M. Droege
Roger Applegate	Alan Clark	John Drury
Jane Arbuckle	Richard Clark	Gene Dumont
Tracey Armstrong	Michael Cline	Charles Duncan
Connie Arness	Ellie Coffin	E. F. Durfee
N. Bailey	Dale Rex Coman	Donald Dyer
Walter Bailey	Phil Conkling	Naomi Edelson
Margaret Baker	Frances R. Cook	Warren Eldridge
Bruce Barker	Iola Cook	C. Elliott
Joyce Barker	A. C. Cooper	Clark Erwin
Nicky Battista	Chris Cooper	Cory Etchberger
William N. Bebb	Ryan Cooper	Karen Etchberger
Dean Bennett	Malcolm Coulter	G.L. Evans
J. Bernatowicz	Connie Cross	Dana F. Ewell
Jim Berry	L. Cross	Norm Famous
Naomi Bishop	Peter Cross	Gale Flagg
Sara Jane Boss	Randy Cross	S. R. Flagg
Bob Bowman	Ken Crowell	John Fleming
Phil Bozenhard	S. L. David	Angela Fletcher
David Brahms	Art Davis	Amy Forrester
Crosby Brown	Lee Davis	J. Forsberg
Jim Brown	C. A. Decks	Carol French
Kris Bull	Karen Detterman	Tom French
Barry Burgason	B. Devereux	Katherine Fricker

## *Acknowledgments*

Fran Frobinson	Kris Kamys	Cynthia Morris
K. Furrow	Donna Kamys	Karen Morris
Bill Galbraith	Alice Kelley	David Mulhearn
J. Gammon	K. Kellogg	Perry N. Moore
Tom Gardiner	B. J. Kemper	Nancy Neilson
G. Getchell	Mark Kern	Katrina Nichols
Cassie Gibbs	Ralph Keyes	Paul Nichols
Bill Glanz	S. Kistenmacher	Dan Nickerson
John M. Glowa	L. Kleifgen	C. Noble
Gerry Godin	Dick Klyver	William Noble
Tom Goettel	C. B. Knox	Chuck O'Brien
Beth Goettel	Sandra Lardeff	Bob O'Leary
Nina Gormley	Linda Leeman	Michael Oldham
T. Graham	Richard Leland	R. Olney
Joe Gray	Jerry Longcore	Ray B. Owen
Anita Grindle	John Lortie	Drustria Packard
Arthur Haines	W. LoSciuto	Robert Packard
Donald Hamilton	Meredith Lozier	Debbie Palmer
Jean Hamlin	Richard Luce	M. J. Parks
Nancy Harnett	Mike Lucey	Brenda Patterson
Jamie Haskins	D. Ned MacLean	Tyson Perry
Audrey Hazen	E. MacWilliams	Trevor Persons
Mike Heath	Charlene Mahns	Barbara Piel
Roger Holton	Don Mairs	J. Edison Pike
Charlotte Howard	Barry Manter	Kim Postle
Wendy Howes	Judy Markowsky	D. S. Potier
Leslie Hudson	Teddy Markowsky	P. Prodan
J. Hull	Jeff Marshall	Chris Raithel
Robert Humphrey	Larry Master	Bill Reddy
Malcolm Hunter	M. Mazurkiewicz	Robert Reddy
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Josh Jacobson	C. R. McLaughlin	Cynthia Richardson
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Tim Stone	Eleta Vaughan	

A smaller group of people merit special thanks for a variety of roles. Barry Burgason, Shirley Davis, and Art Ritter constituted, along with the editors, a MARAP steering committee that shaped the project during its inception. Alan Hutchinson, of the Maine Dept. of Inland Fisheries and Wildlife Endangered and Nongame Wildlife Fund, and Mark Anderson, of the Maine Agricultural Experiment Station, organized funding for various phases of the project. James Bogart of the University of Guelph, Ontario, provided laboratory analysis of blue-spotted salamander and toad specimens collected by Carroll Knox that were critical for understanding the taxonomy of these species in Maine. Jim Connolly and Art Ritter produced the Maine range maps, and Trevor Persons and Wayne Persons produced the North American range maps. Trevor Persons and Arthur Haines assisted with preparing the Maine bibliography and literature cited. Two sections, "Introduction" and "Finding and Conserving Maine's Amphibians and Reptiles," were written by Mac Hunter, except as otherwise indicated. Bill Glanz, Brian Sullivan, and Steve Hinshaw critiqued various drafts of the manuscript. Shirley Moulton provided secretarial assistance. Barbara Harrity copyedited the manuscript and created the layout using desktop publishing software. Finally, we wish to thank Mark McCollough, the artist, and all the authors identified throughout the book. We mention them last, not because their contribution is least, but because their achievement will be obvious to all readers of this book.

## AN INTRODUCTION TO AMPHIBIANS

In the long history of life on earth, amphibians played a pivotal role as the first vertebrates to leave the water for a terrestrial existence. This transformation, roughly 360 million years ago, allowed amphibians to flourish with little competition from other vertebrates and evolve as many as 15 major groups over the next 125 million years. However, with the advent of reptiles, and later birds and mammals, the amphibians have waned, and today they are represented by only three orders: frogs and toads (Anura), salamanders (Caudata), and caecilians (Gymnophiona), a group of worm-like creatures confined to the tropics.

The movement from water to land required a number of adaptations: limbs for support and locomotion in a medium (air) which lacks the buoyancy of water; lungs and moist skins for exchanging gases with the air; a skin that would minimize loss of water through evaporation; and eggs that would not desiccate out of water. Amphibians have not been entirely successful in making these adaptations. Most species must still return to water, or at least a very moist environment, to breed. This is the basis of the name, amphibian, as in amphibious (*amphi* = both; *bios* = mode of life). Similarly, the mucous-covered skins of most amphibians are not very impervious to water loss, and thus most amphibians are confined to moist habitats such as wetlands or underground, or to nocturnal lifestyles. These limitations explain why amphibians are uncommon in deserts or marine environments (where the water's high salt concentration also creates a desiccating environment).

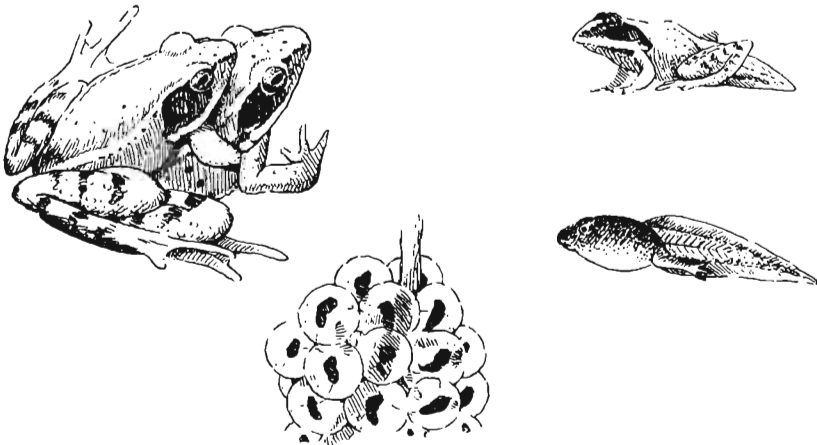
Amphibians are also not well adapted for activity at cold temperatures because their metabolic rates are too low to generate enough heat to maintain a stable body temperature. In common parlance this makes them "cold-blooded"; more formally they are called ectothermic (meaning their body heat is obtained from the environment) or poikilothermic (their body temperature is variable). This means they are nearly absent from tundra and alpine environments, and in temperate regions they are usually dormant through the winter months. It does not mean that they are completely at the mercy of their environment. Through various methods—like basking in a warm spot—they can remain active at quite low temperatures, often much lower than many reptiles.

In addition to coping with climatic constraints, amphibians must contend with a vast array of predatory fish, reptiles, birds, mammals, and occasionally insects. Some amphibians have toxins in their skins to discourage predators; some frogs can make an impressive hop away from a predator; but generally amphibians are consumed in large numbers. Amphibians are not just victims in the predator-prey dynamic. They are also predators themselves feeding on a wide array of invertebrates and occasionally small vertebrates. Only as larvae do some species add algae and other plants to their diets.

To offset losses to predation many species of amphibians take a shotgun approach to reproduction. In other words, they produce many young to increase the probability that at least a few will survive and carry their genes into the next generation. Usually this means that the female simply sheds her eggs and leaves them to hatch and survive on their own. One elaboration on this theme is "predator-swamping." By congregating in a few breeding sites, amphibians may saturate predators with far more amphibian larvae than they can eat. This is not the only explanation for why many amphibians congregate to breed. For example, the vocalizations produced by male frogs and toads during the breeding season may allow the females to compare and select a mate from the assembled choir. In some cases, simply the scarcity of suitable breeding sites may explain the concentrations.

The actual act of mating is quite different for anurans (frogs and toads) and salamanders. Anuran males grasp the females' torsos from above and behind, an embrace called amplexus, and fertilize the eggs as they are shed. Most male salamanders deposit a small capsule of sperm called a spermatophore, then undertake a complex ritual to persuade the female to take up the spermatophore into her cloaca (a common chamber where the urinary, digestive, and reproductive systems terminate).

When herpetologists consider the biology of amphibians and try to explain why people should be concerned about their welfare they often write about amphibians as predator or prey: prey of species that we care about more, such as birds, or predators of species that we like less, such as insects. Sometimes they speak of amphibians as useful biological models: could doctors learn to regenerate human limbs by emulating the processes that amphibians use to grow back a severed appendage? A few species have direct economic importance, as a source of gourmet frog legs for example. Seldom do we allow that they might have value in and of themselves, independent of human perspectives.



*Life cycle of the wood frog.*



## AN INTRODUCTION TO REPTILES

About 315 million years ago a lizard-like reptile evolved from an amphibian by developing two special features—a skin and an egg covering that were relatively impervious to water loss. Having been emancipated from a dependence on wet habitats, reptiles became a dominant life-form in terrestrial ecosystems. Indeed, it is common to refer to the period from 280 to 65 million years ago as the age when “dinosaurs ruled the earth.” Although this perspective is probably unfair to plants and insects, it is certainly true that reptiles were far more important then, than they are today. If it were not for the popular fascination with dinosaurs and the animated movies it has spawned, it would be hard to imagine a world in which mammals were just tiny shrew-like creatures completely dwarfed by reptiles, the largest of which weighed 60–90 tons and was over 40 meters long.

Although the number of species and abundance of reptiles may have declined, today's reptiles are not just antiquated relics on their way to extinction. They inhabit all the world's major terrestrial, freshwater, and marine ecosystems except polar seas and tundra areas. They even persist in some very dry deserts where no birds or mammals survive.

Reproduction on land has been a key to success and, with the exception of some sea snakes, all reptiles produce their young on land. Most species are oviparous, producing eggs that are either hard and brittle because they are calcified like a bird egg, or eggs that have a parchment-like covering. Some lizards and snakes produce living young that emerge from a membrane at or just before birth. Technically, these species are ovoviviparous (rather than viviparous, the term used for mammals) because there is a yolk that provides most of the embryo's nutrition. In a few reptiles, the yolk is reduced and much of the nutrition comes directly from the mother, making them more similar to mammals. Because fertilization usually takes place on land, it is internal, and most male reptiles have an organ for copulation. Only tuataras (a New Zealand reptile that superficially resembles a lizard) copulate like birds—cloaca to cloaca. Parental care is absent or limited in most reptiles, but there are some noteworthy exceptions, such as pythons that incubate their eggs, and crocodiles that guard their nests and carry their newly hatched young to water.

Like amphibians, reptiles have a low metabolic rate and lack insulating fur or feathers, and thus they must use behavioral mechanisms like basking to maintain their body temperature. One major advantage of this strategy is that it minimizes energy demands; on average a bird or mammal needs 30–50 times as much food as a reptile of the same size.

Taxonomists divide living reptiles into four orders: Chelonia (turtles and tortoises), Crocodylia (crocodiles and alligators), Rhynchocephalia (the tuatara), and Squamata—which are further subdivided into three suborders: Sauria (lizards), Serpentes (snakes), and Amphisbaenia (worm-lizards). Only snakes and turtles occur in Maine, and thus some further description of them is appropriate here.

Perhaps no other group of animals elicits such strong emotional responses from people as snakes. Their slithering locomotion, their staring, lidless eyes, and the lethal venom of some species combine to make them very unpopular with most people, the incarnation of evil for a few. In contrast, some cultures—notably Hindu and Buddhist societies—revere snakes because they see snakes' ability to shed their old skin as a model for reincarnation, and their elongated, phallic shape as a symbol of fertility. The lack of limbs does not limit snakes' locomotion very much. Most species can move rapidly over the ground, climb trees adeptly, and swim well. In fact, their lack of limbs is a decided advantage moving underground or in other constricted spaces. Thus they can pursue their prey (all snakes are predators) in places that are inaccessible to many other predators with which they compete for food. In these tight places they are also safe from most of the predators that treat snakes as prey. Fitting organs into this long slender shape has necessitated adaptations; for example, most species only have one functional lung. Similarly, fitting prey into their bodies (they always swallow their prey whole) requires flexible skin, ribs, and jaw bones.

In some respects turtles are just the opposite of snakes. Instead of a supple, flexible body, turtles fit their bodies into a shell consisting of a carapace (top) and a plastron (bottom) joined by a bridge. This shell is a marvelous fusion and modification of the skeleton that gives turtles a secure armor without eliminating their mobility. Of course, there is some reduction of mobility and turtles are not known for running and jumping. (But some marine turtles can swim at 19 mph, as fast as humans run.) Limited mobility means that most turtles forage on slow or sedentary prey—vegetation, carrion, invertebrates like slugs and worms—tearing their food into bits small enough to fit into the shell with them. Some turtles are adept “sit-and-wait” predators, snapping up prey that venture too close; a few are active pursuers. As slow-moving ectotherms, turtles have certain advantages: they live for a long time—perhaps hundreds of years; they require relatively little food; and they need little oxygen and thus can stay underwater for long periods.



*Hatchling black racers.*

## MAINE'S ENVIRONMENT AS HABITAT FOR AMPHIBIANS AND REPTILES

Maine is a big state by eastern United States standards, spanning more than 700 kilometers (450 miles) and nearly five degrees of latitude from south to north. It is also topographically diverse, ranging from a coastal plain at sea level to mountains with a maximum elevation of 1596 m (5,267'). This physical diversity creates a broad range of climatic conditions in Maine that affect where and how amphibians and reptiles live, especially because they are ectothermic, or cold-blooded. Specifically, climate is critical to their ability to maintain an adequate body temperature to sustain vital life functions, and to complete their reproductive activities in Maine's brief summers.

The relationships among Maine's vegetation, climate and physical features were investigated by Janet McMahon (1990) in a thesis titled "The biophysical regions of Maine: Patterns in the landscape and vegetation." McMahon's study demonstrated that the effects of latitude, elevation, and the moderating effects of the ocean work together to create a steep climatic gradient from the coast to extreme northwestern Maine.

Near the coast of Maine, winter temperatures are generally warmer than in inland sections because of the moderating effect of the ocean on climate. Water does not change temperature as quickly as air, so the temperature of the ocean lags behind the ambient air temperature. Thus, air temperatures in winter along the immediate coastal plain are warmer than inland areas. (The converse is true in summer; a relatively cooler ocean results in cooler temperatures along the coast, creating a pleasant climate for herps and humans.)

Latitudinal and elevational changes are also important influences on climate because air temperature drops at higher latitudes and higher elevations. In Maine, as one travels farther inland away from the coast, latitude and elevation both increase causing average annual temperatures to become cooler. This gradual change in temperature is accentuated, however, by a relatively sharp elevational break that occurs along a broad band roughly following the western Maine mountains, through Greenville to Millinockett, and north to the northern tip of Maine. The cold and long winters found above this break make this the most inhospitable region for herps.

Elevational variation in Maine is partly a product of the geological forces that create mountains. The most significant geological force acting on Maine, however, was the glaciers, which at one time covered Maine with ice three miles thick. The erosional and depositional actions of the glaciers put the finishing touches on Maine's landscape, and created the myriad lakes, ponds, and wetlands that now provide habitat for many species of reptiles and amphibians. The glaciers also left some extensive sandy, outwash plains

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that, in southern Maine, provide habitat for herp species with more southern affinities.

Humans have also shaped the landscapes of Maine in a variety of ways that affect herps and their distributions. Deforestation and conversion to farmland (and the opposite process of reversion to forestland) can shift herp distributions by creating habitat that favors some species over others. Large-scale industrial or commercial development, and the cumulative effects of residential development, on the other hand, eliminate habitat altogether, and may threaten some species.

Thus Maine, with its climatic extremes and changing landscapes, offers a challenge to small cold-blooded herps. The world is not static, and we can be sure that the climate and landscapes of Maine will continue to change. How they change will be important to the species that currently, or will someday, occupy Maine.

John Albright, Maine Natural Heritage Program, Augusta



# A CHECKLIST OF MAINE AMPHIBIANS AND REPTILES<sup>1</sup>

Scientific Name	Common Name
<b>AMPHIBIA</b>	<b>AMPHIBIANS</b>
<b>CAUDATA</b>	<b>SALAMANDERS</b>
Proteidae	
<i>Necturus maculosus</i>	Mudpuppy
Ambystomatidae	
<i>Ambystoma laterale</i>	Blue-spotted Salamander
<i>Ambystoma maculatum</i>	Spotted Salamander
Salamandridae	
<i>Notophthalmus viridescens</i>	Eastern Newt
Plethodontidae	
<i>Desmognathus fuscus</i>	Dusky Salamander
<i>Eurycea bislineata</i>	Two-lined Salamander
<i>Gyrinophilus porphyriticus</i>	Spring Salamander
<i>Hemidactylium scutatum</i>	Four-toed Salamander
<i>Plethodon cinereus</i>	Redback Salamander
<b>SALIENTIA (ANURA)</b>	<b>FROGS AND TOADS</b>
Bufonidae	
<i>Bufo americanus</i>	American Toad
Hylidae	
<i>Hyla versicolor</i>	Gray Treefrog
<i>Pseudacris crucifer</i>	Spring Peeper
Ranidae	
<i>Rana catesbeiana</i>	Bullfrog
<i>Rana clamitans</i>	Green Frog
<i>Rana palustris</i>	Pickerel Frog
<i>Rana pipiens</i>	Northern Leopard Frog
<i>Rana septentrionalis</i>	Mink Frog
<i>Rana sylvatica</i>	Wood Frog

<sup>1</sup> The taxonomy of this list generally follows Collins 1990, except that subspecies names are given only for those species that have more than one subspecies in Maine.

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Scientific Name	Common Name
<b>REPTILIA</b>	<b>REPTILES</b>
<b>TESTUDINES (CHELONIA)</b>	<b>TURTLES</b>
Chelydridae	
<i>Chelydra serpentina</i>	Snapping Turtle
Kinosternidae	
<i>Sternotherus odoratus</i>	Common Musk Turtle
Emydidae	
<i>Chrysemys picta picta</i>	Eastern Painted Turtle
<i>Chrysemys picta marginata</i>	Midland Painted Turtle
<i>Clemmys guttata</i>	Spotted Turtle
<i>Clemmys insculpta</i>	Wood Turtle
<i>Emydoidea blandingii</i>	Blanding's Turtle
<i>Terrapene carolina</i>	Eastern Box Turtle
Cheloniidae	
<i>Caretta caretta</i>	Loggerhead
<i>Lepidochelys kempii</i>	Atlantic Ridley
Dermochelyidae	
<i>Dermochelys coriacea</i>	Leatherback
<b>SERPENTES</b>	<b>SNAKES</b>
Colubridae	
<i>Coluber constrictor</i>	Racer
<i>Diadophis punctatus</i>	Ringneck Snake
<i>Lampropeltis triangulum</i>	Milk Snake
<i>Nerodia sipedon</i>	Northern Water Snake
<i>Opheodrys vernalis</i>	Smooth Green Snake
<i>Storeria dekayi</i>	Brown Snake
<i>Storeria occipitomaculata</i>	Redbelly Snake
<i>Thamnophis sauritus sauritus</i>	Eastern Ribbon Snake
<i>Thamnophis sauritus septentrionalis</i>	Northern Ribbon Snake
<i>Thamnophis sirtalis sirtalis</i>	Eastern Garter Snake
<i>Thamnophis sirtalis pallidulus</i>	Maritime Garter Snake
Viperidae	
<i>Crotalus horridus</i> *	Timber Rattlesnake*

\*Extirpated

## THE RANGE MAPS

The species accounts include range maps showing for which towns a record was submitted by a MARAP participant. In the best of all possible worlds, as perceived by a professional herpetologist, these range maps would be confirmed by large numbers of preserved specimens. There would be individual specimens from here, there, and everywhere and from some locations large collections that could be examined for local variations. By the strict rules of science, only properly labeled specimens deposited in museums constitute valid records. Although our goal required having large numbers of reliable records, we could not justify collecting large numbers of specimens, especially because most MARAP participants were unwilling to sacrifice animals for science. This was particularly true because, rather ironically, the only species for which it was really important to obtain verified records, were the uncommon species whose populations might be most vulnerable to collecting.

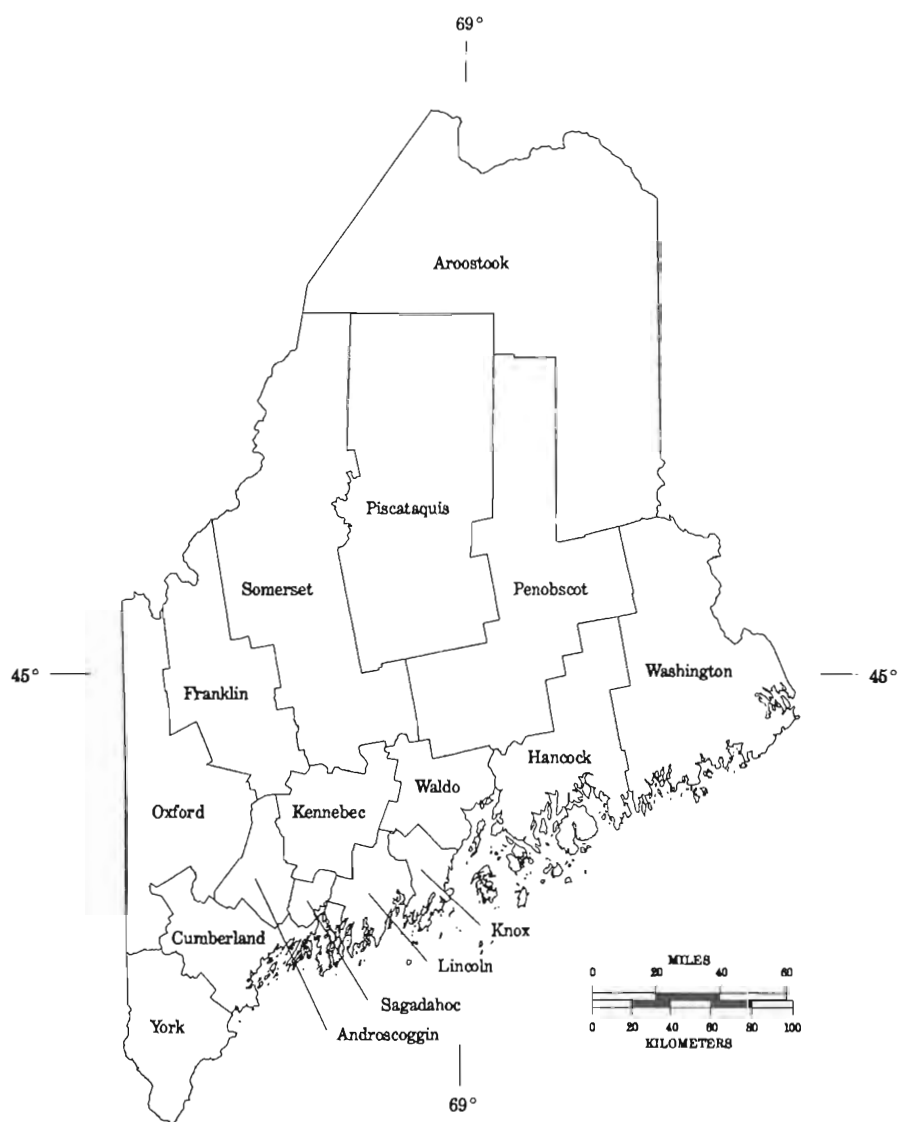
Because of these issues, we used three levels of verification reflecting decreasing levels of confidence in a record:

1. A specimen was collected and preserved or a recognizable photograph taken.
2. A specimen was handled then released.
3. A specimen was seen or heard but not captured.

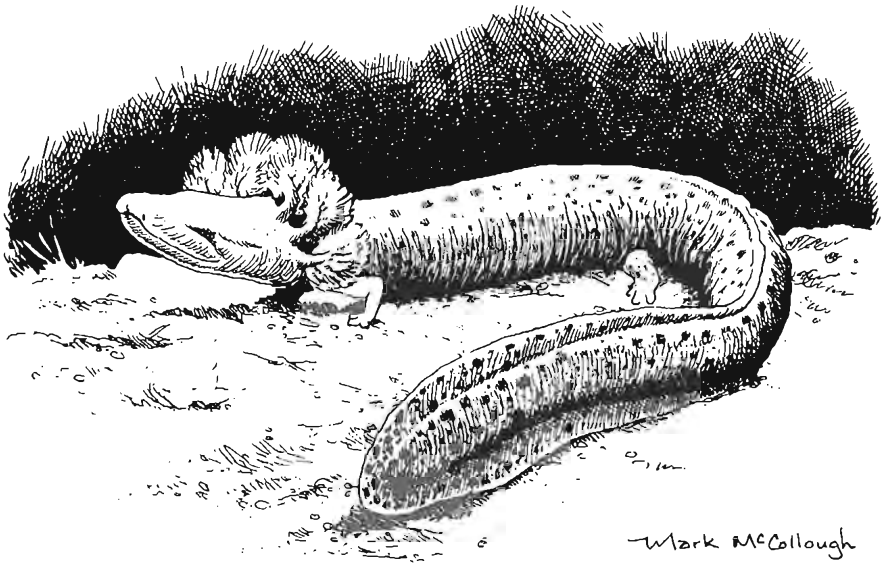
The range maps distinguish among these levels of confidence using different types of shading: solid shading for specimens or photographs, cross-hatching for "handled" records, and diagonal lines for "seen/heard" records.

For species of conservation concern we continued to gather data after the formal end of MARAP in 1988. New locations for these specimens are indicated with a small dot. Many of the species accounts describe distributions verbally using the names of counties and other major geographical features and thus a map is provided on page 14 for readers unfamiliar with Maine geography. The entire North American ranges of species are shown in small maps based on the work of Conant and Collins (1991), Ernst and Barbour (1989), Smith (1978), and Stebbins (1985).

*The Amphibians and Reptiles of Maine*







## MUDPUPPY

*Necturus maculosus*

The mudpuppy is not only Maine's largest salamander, but also the only amphibian or reptile species known to have been introduced here—albeit accidentally—by humans. The subjects of research by a Colby College biology professor, mudpuppies escaped into an inlet of Great Pond in the Belgrades on two separate occasions, once in the fall of 1939, and again one winter in the early 1940s. Which of the escapes resulted in today's population, we will probably never know; it is, however, documented that the first fugitives came from Pennsylvania the spring of their escape; the second lot were adults purchased from a biological supply house (Crocker 1960). In any event, this striking creature was well-established in Great Pond by the late 1950s, a fact not celebrated by local anglers, who feared possible adverse effects on the well-known trout and salmon fisheries of the Belgrade Lakes. Public concern has abated considerably, and the mudpuppy, still detested by some and loved by few, is today largely unknown to many residents and most visitors to the Belgrade area. The species has received little scientific attention in this state, and even its present distribution in the Belgrade chain is largely a matter of speculation.

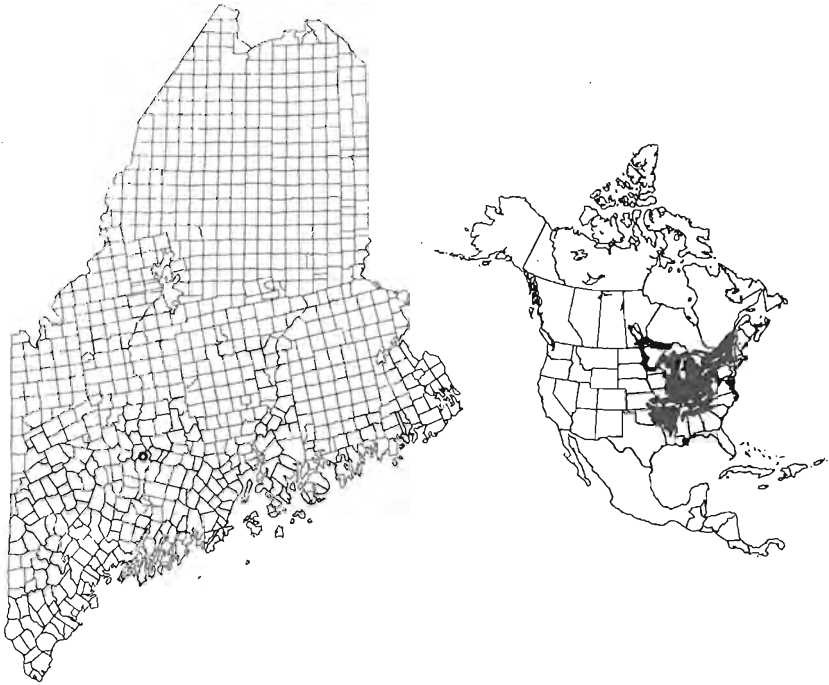
**DESCRIPTION:** Mudpuppies are large, brownish, completely aquatic salamanders with three pairs of red, bushy, permanent external gills. Most specimens examined from Maine range from 20 cm (8") to 30 cm (12") in total length, with muscular, elongated bodies, broad, flat heads, and small round eyes. The tail is flattened from side to side, and the short, stout legs each have four somewhat stubby toes. The mouth is quite large, extending posteriorly to just behind the eyes, and contains two rows of short, sharp teeth. The brown color shades to a deep rusty hue, with rounded blackish spots distributed randomly over the body; some specimens lack these spots on their undersides.

Newly hatched larvae have an average length of 2–2.5 cm (0.75–1.0"), and by fall of the next year have reached 5–6 cm (2"–2.5"). Growth is steady and gradual until by the fifth year specimens average nearly 19 cm (7.6"). Most mudpuppies apparently reach sexual maturity in the sixth year, although small individuals may only have attained a length of 20 cm (about 8") by that time. Larval mudpuppies are colored differently from adults, with yellow and brown longitudinal bands extending along the back and sides; these bands largely fade to adult coloration by the fourth year.

The mudpuppy is the only Maine salamander to retain external gills into and throughout its adult life; this characteristic, along with its size, color, and completely aquatic habit, distinguish it from all other salamanders found here. Only a young spring salamander that had retained its gills could be mistaken for a mudpuppy. Mudpuppy larvae may be distinguished by the absence of eyelids and their longitudinal bands.

**DISTRIBUTION AND STATUS:** The only published records of the mudpuppy in Maine are from Great Pond in the Belgrade chain of lakes (Crocker 1960; Foye 1961). State fishery biologists, however, have collected it from Long Pond, the next lake below Great Pond. There seems no reason to believe that these salamanders would not have spread below Long Pond to Messalonskee Lake, and possibly even beyond the Belgrades via Messalonskee Stream to the Kennebec River. Upstream migration in the Belgrades would appear more problematic, although for many years there was no significant barrier to upstream movement from Great Pond into North Pond. An unconfirmed newspaper article in 1986 reported a mudpuppy caught through the ice on North Pond. Unfortunately, the term "mudpuppy" has come into somewhat general use in central Maine to denote any large salamander including the spotted salamander; this makes the task of evaluating anecdotal observations much more difficult.

**HABITAT:** Mudpuppies are known to tolerate a broad range of aquatic conditions, from deep oligotrophic lakes to shallow marshes and even polluted and stagnant drainage ditches. Great Pond is a large (3,280 hectare or 8,200 acre), deep, clear, cold lake. Its tributaries include numerous small brooks, two fairly large, marshy streams, and one intermittently rapid



stream (Hatchery Stream, the site of the mudpuppies' original introductions). *Necturus* has been taken from many areas of the lake, largely by anglers and bait collectors, but it concentrates in Hatchery Stream from late April to late May and is thus best known from that location.

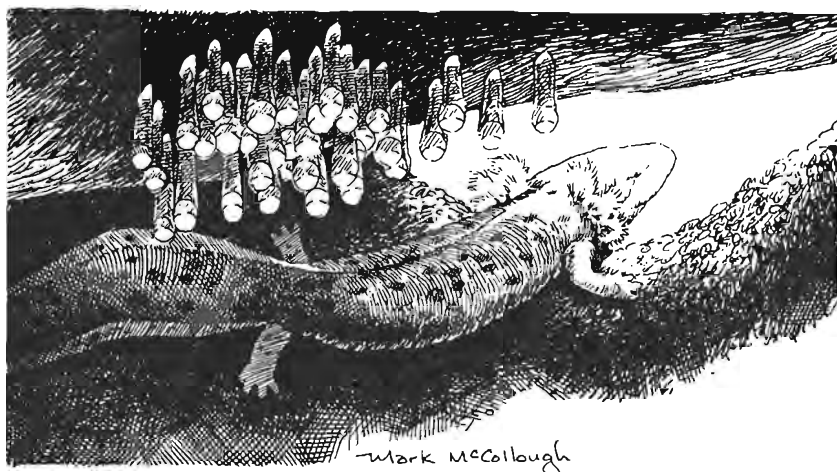
**REPRODUCTION:** Elsewhere in the mudpuppy's range, mating and sperm transfer occur in the fall, but females do not lay their eggs until spring and summer of the following year. Nests are located in either lakes or streams and usually consist of excavations scooped out under large rocks or submerged logs. The eggs are 5 to 6 mm in diameter (1/5") and are attached singly by stalks to the cover over the excavated nests. The number of eggs in a cluster varies widely, but usually averages from 60 to 100; they are guarded by the female during the incubation period. Hatching occurs in from 38 to 63 days (Bishop 1941).

**DIET:** Little is known of the dietary habits of Maine mudpuppies, but extensive studies elsewhere have found insects and crayfish to be predominant items. Fish and fish eggs are also taken, as are worms, leeches, snails, and other salamanders. Plant matter and stones have been reported from mudpuppy stomachs, but whether these items were ingested purposely or incidentally is apparently unknown.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Human reaction to the successful colonization of Great Pond by *Necturus* was initially hostile. Area anglers had been sensitized to the presence of exotic species in this lake by the accidental stocking and establishment of walleyes, a development to which they and the state responded by a vigorous spearing campaign on the walleyes' spawning shoals. It was, in fact, while spearing walleyes that many anglers first became aware of the presence of mudpuppies in Great Pond. The spearing was apparently successful in extirpating walleyes from the lake, and for a few years some local residents made an effort to eliminate mudpuppies by spearing and dipping them from Hatchery Stream in early spring. Any organized effort in this direction has long since ceased, and *Necturus* populations are now probably governed largely by the same vicissitudes as those encountered by native species.

The actual significance of mudpuppy predation on game and forage fish populations seems not to have been conclusively studied; likewise, the effect on fish of the obvious competition for food items seems unknown in any quantitative sense. On the other hand, the fondness of bass, walleye, and northern pike for larval and adult mudpuppies has been known to southern and midwestern anglers for some years. Recently, "waterdogs" (a term which includes not only mudpuppies but larvae and neotenes of other salamander species, especially the tiger salamander (*Ambystoma tigrinum*), have become available from mail-order bait shops. State of Maine law prohibits such importation, but it is possible that by now mudpuppy introductions have been made into other Maine drainages via the bait pail, and that one day other salamander species will become established here in the same way.

Donald F. Mairs, Belgrade, Maine



*Female mudpuppy defending nest.*



## BLUE-SPOTTED SALAMANDER

*Ambystoma laterale*

At about the time when the wood frogs are aroused from hibernation by melting snow and warm spring rains, the secretive blue-spotted salamanders also appear. Then, on rainy nights, they may be discovered crossing roads in great numbers on the way to the breeding pools they share with wood frogs, spring peepers, and spotted salamanders. The rest of the year they are widely dispersed in wooded areas, where they are securely concealed and seldom seen. For many years, this species was confused with the similar-appearing Jefferson salamander (*Ambystoma jeffersonianum*), and both were known by that name. Adding to the confusion, and now included in this group, are the polyploid hybrids of the blue-spotted and Jefferson salamander, which were formerly known as Tremblay's salamander, and silvery salamander.

**DESCRIPTION:** In color, blue-spotted salamanders are reminiscent of old-time enameled cookware, which was finished with a dark blue black background liberally sprinkled with bluish white flecks. Submerged in the breeding pools, adults appear to be a nondescript medium mud brown, their true colors only being revealed when they are taken from the water. Hybrids (discussed below) tend to be more brownish. The bluish white specks or irregular spots may be distributed quite uniformly over the body and tail, or

may be confined mainly to the limbs, lower sides, throat, and belly. The colors may be paler on the underside.

Breeding adults in Maine measure 9.8 to 12.7 cm (3.9–5") total length. Hybrids are larger, ranging up to 17 cm (6.8"). The tail is long and laterally compressed, and averages 44% of the total body length. Lost tails can be regenerated, and short-tailed specimens are occasionally found. In well-nourished specimens the tail is quite plump, with grooves running downward from the upper edge. These often resemble the 12 to 15 costal grooves on the body. There are four slender toes on the front and five on the hind feet. The head is quite narrow and tapers to a rounded snout. During the breeding season, males may be identified by the puffy, swollen area around the vent, which is caused by enlargement of the cloacal glands. The larvae are olive green to black and have a long dorsal fin that extends from behind the head along the back and tail.

Although there is some resemblance between the blue-spotted and dusky salamander and the "lead-back" phase of the redback salamander, close examination will readily distinguish them. The dusky salamander's hind legs are much thicker and stockier than the front, and there is a light diagonal streak from behind the eye to the angle of the jaw. The redback salamander is smaller and more slender, with a proportionately longer rounded tail, and 19–22 costal grooves compared to 12–15 in the other two species. The redback salamander is also entirely terrestrial, even breeding on land.

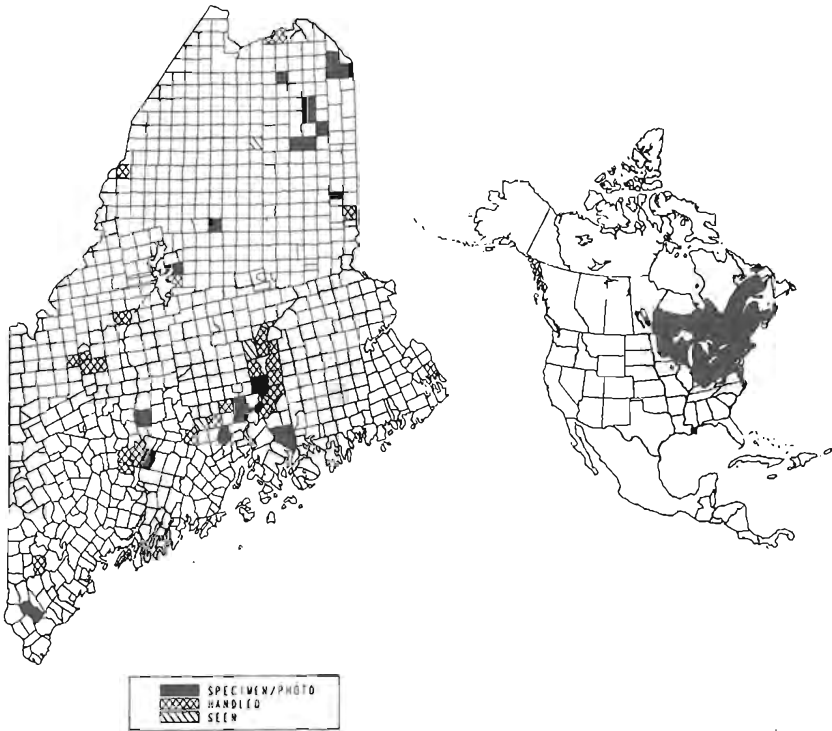
**TAXONOMIC STATUS:** The taxonomy of the blue-spotted salamander and its close relative, the Jefferson salamander, is complex and confusing. For many years herpetologists called them both Jefferson salamander, but later information suggested that two species had evolved from a common ancestor during the last Ice Age, when two populations were kept apart by glaciers. When the ice receded, about 10,000 years ago, the two new species migrated into the newly exposed land, where they met and interbred, producing hybrids. Each of the parent species normally has *two* sets of 14 chromosomes and are thus referred to as *diploid*. But the hybrids they produced have *three* sets of 14 chromosomes, and are referred to as *triploid*. The triploid hybrids are nearly all females and have measurably larger red blood cells as well as larger cell nuclei in other body tissues. Uzzell (1964) proposed that the hybrids should be divided into two new species, depending upon which parent's genetic material had been inherited in greatest quantity. Those with two sets of blue-spotted and one set of Jefferson genes (genome = LLJ) he called *Ambystoma tremblayi* or Tremblay's salamander. Those having a superior number of Jefferson genes (genome = LJJ) were named *A. platineum*, the silvery salamander. These designations were soon challenged, but have nevertheless been used in the literature, including popular field guides, ever since (Behler and King 1979; Conant 1975).

Recently, however, research has shown that the genetic structure of some hybrids is far more complicated than originally suspected. Some, including one specimen collected in northern Maine (MCZ A-110610), have been found to be tetraploids with *four* sets or a total of 56 chromosomes. Equally important, the evidence indicates that neither of the major, predominantly female, hybrid types could long exist without continued contribution of male factors from either parent species. The inability to independently sustain their own unique populations disqualifies the hybrids as separate and distinct species. It has been proposed that the hybrids should henceforth be referred to as *Ambystoma laterale* x *jeffersonianum* or the same with a parenthetical number before the appropriate species name (e.g., *A. (2) laterale* x *jeffersonianum*) if the genome is known (Lowcock et al. 1987). Some authorities are already adopting these designations (Klemens pers. comm.; Knox 1989). We endorse these proposals and therefore do not address *A. tremblayi* as a valid Maine species.

Anyone finding a salamander with blue spots in Maine thus cannot know whether it is an *Ambystoma laterale* or one of the hybrids formerly called Tremblay's salamander. True identity of the specimen can only be determined by laboratory procedures, including measurement of red blood cells or epidermal nuclei, chromosome counts, and protein electrophoresis. Studies done in 1987 suggest that in Maine there is a 70% chance the specimen is a hybrid (Knox unpubl. data). Genetic evidence from the same study suggests that the Jefferson salamander is unlikely to be present anywhere in Maine (Bogart pers. comm.).

**DISTRIBUTION AND STATUS:** In the course of the MARAP project (1984–1988), blue-spotted or “Tremblay's” salamanders were recorded in ten of Maine's 16 counties. These records indicate that the species and its hybrids probably occur throughout the state, although they are much less frequently reported than their near relative, the spotted salamander. Most of the earlier records represent only presumptive identification based upon outward characteristics, but a special study done in 1987 with full laboratory verification of identity suggests that the great majority of Maine's blue-spotted salamanders are hybrids. Only two relic populations of genetically pure *A. laterale* salamanders are currently known, one on Prince Edward Island (Canada) and the other on Long Island, New York, where they may have been isolated by rising sea levels as the Ice Age glaciers melted (Stutz 1987).

**REPRODUCTION:** Migration to the breeding pools begins in early April in southern Maine and about three weeks later in the north. Semi-permanent pools with overhanging bushes and grass, sphagnum moss margins, or leafy bottoms are favored when available. Abandoned beaver flowages, highway ditches, and flooded sections of old logging roads are also used. Such sites are most often in or near deciduous or mixed forest. Water depth is seldom more than 30–40 cm (12–15") and often less.



The breeding cycle is brief. Adult salamanders and freshly laid eggs have been observed in the breeding pools up to 17 days after the first migrants had appeared (Knox unpubl. data). Courtship involves an elaborate series of approach, contact, nudging, and tail-fanning routines that culminate in the male depositing a spermatophore, which is picked up and stored in the cloaca of the trailing female (Duellman and Trueb 1986). The male is not present when the eggs are deposited shortly afterward. The eggs are fertilized as they pass through the female's cloaca. Being only slightly adhesive, they fall to the bottom singly or cling lightly to vegetation in loose groups of 2–8. Ordinarily, their large, clear jelly capsules make them virtually invisible in the water. In one instance, eggs that were deposited in a shallow, mud-bottomed puddle became completely coated with fine sediment and were clearly discernible as scattered round balls on the bottom (Knox unpubl. data). Diploid *A. laterale* females produce as many as 500 eggs, but triploid hybrid females are less fecund and produce only about 300 eggs, despite their greater body size (Gilhen 1984).

The free-swimming, limbless hatchling larval phase is brief, ending when the forelegs develop and become functional. The hind legs soon appear, and the larvae become bottom dwellers. More mature larvae are robust and nearly black, with a prominent ruff of external gills and a broad-finned tail. They are entirely carnivorous, and can often be seen stalking stealthily over the open bottom in search of prey. Impending metamorphosis is signalled by



degeneration of the gill branches and frequent excursions to the surface to gulp air. In northern Maine, newly transformed individuals average about 5 cm (2") in total length, but a series measured by Gilhen (1984) in Nova Scotia were somewhat larger, averaging 6.5 cm (2.5").

Newly transformed juveniles retain noticeable, blackened gill stubs for several days, but acquire the adult colors and spot patterns within 24 hours after leaving the water. On rainy nights in late summer, large numbers of these transformants may journey from the ponds to terrestrial habitat. Though most escape notice because of their dark color and small size, many can be found crossing roads in wooded areas during these migrations.

**HABITAT:** After the breeding season, blue-spotted salamanders disperse into wooded areas, where they seek shelter by burrowing under rocks, rotting stumps and logs, mats of moss and vegetative debris, or in loose soil. They have also been found in wood piles, under discarded lumber, old tarpaulins, and sheets of metal in rural yards, and are occasionally discovered in residential cellars in the fall. The damp, moderately shaded environment that is provided by deciduous or mixed forest appears to be their favored habitat.

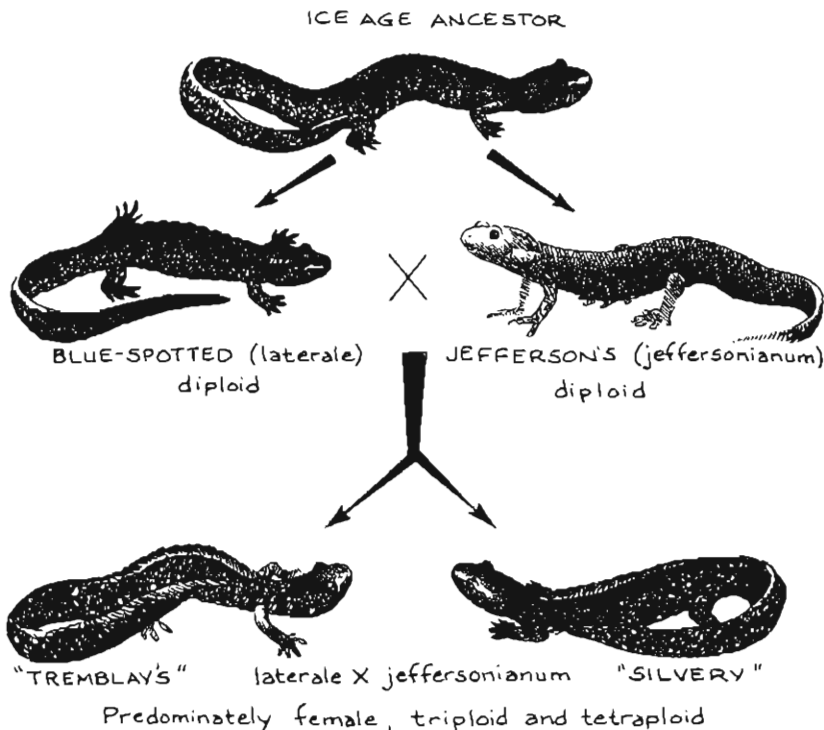
**DIET:** Small larvae feed on a wide assortment of planktonic animals, gradually shifting to larger aquatic worms, insect larvae, and small crustaceans as they grow. Nearly mature larvae are also capable of capturing small tadpoles and fish fry. In over-crowded habitat, cannibalism also occurs. Adult blue-spotted salamanders commence feeding upon rousing from hibernation, first taking advantage of aquatic insect life encountered when they reach the breeding sites. In their terrestrial habitat the rest of the year, they consume a wide variety of larval and adult insects, spiders, centipedes, earthworms, slugs, and snails.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Like other amphibians, blue-spotted salamanders are affected by a multitude of factors that influence survival and control populations. Mortality due to predation, disease, and environmental hazards is undoubtedly highest during the most susceptible larval and metamorphic stages of their life cycle. The small percentage that reach adulthood depend upon various strategies to survive. Almost any predator will try to eat a salamander. Concealment by burrowing offers obvious protection. Color patterns may hinder detection by visually oriented predators, or warn them of noxious secretions. A curious defensive posture in which the tail is raised vertically and undulated from side to side has been documented (Brodie 1977). The movement attracts the predator to the tail, which is richly endowed with glands emitting noxious secretions, and is also the most dispensable part of the salamander. Some specimens react by biting when suddenly grasped, which seldom inflicts injury but may startle the predator into releasing the salamander and allowing its escape.

Habitat destruction poses a direct threat to survival of the blue-spotted salamander. Although clearcutting, forest fires, reforestation exclusively with evergreen species, spraying insecticides or herbicides may not eliminate them, populations may be reduced in such areas. The possibility of such impacts should be investigated. In one recorded instance, an area which had been heavily populated with blue-spotted salamander larvae for the previous three years was completely destroyed when highway crews dredged grassy roadside ditches down to bare soil (Knox unpubl. data).

In recent years there has been increasing evidence that acid precipitation could severely affect the survivability of amphibian eggs and larvae in breeding pools, especially vernal pools formed from meltwater. High water acidity (low pH) has been shown to cause egg shrinkage, larval deformity, and hatching failure. The rate and extent of jelly expansion in newly laid eggs are also related to water ion balance. Incomplete or reduced jelly expansion can make the eggs more susceptible to injury, fungal infection, or ingestion by predatory fish and salamanders.

Carroll B. Knox, Caribou, Maine



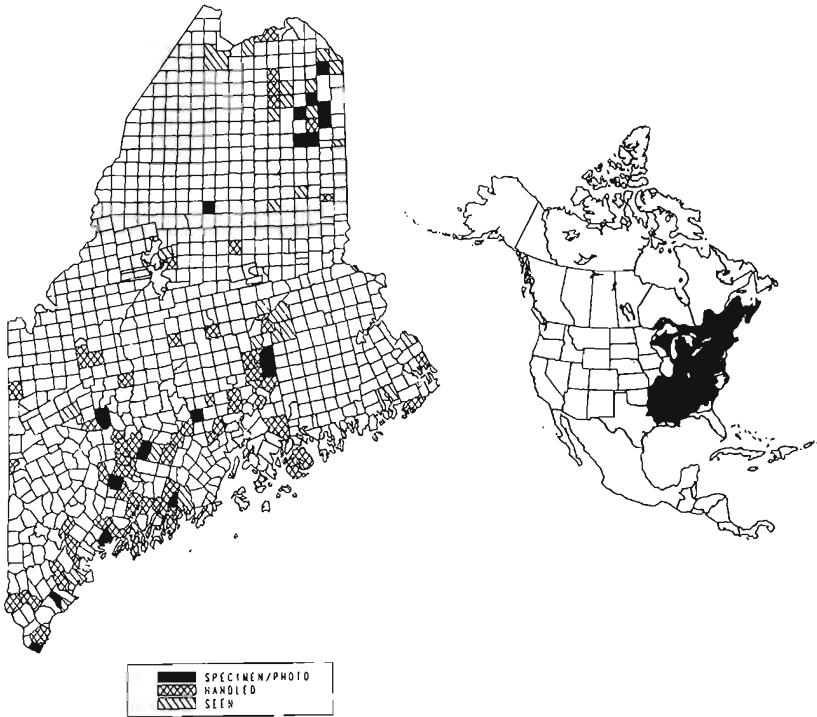


## SPOTTED SALAMANDER

*Ambystoma maculatum*

When the first warm temperatures bring spring rains and melting snow, a mass migration takes place in the forest of eastern North America. *Ambystoma maculatum*, the spotted salamander, emerges from its underground haunts and converges on vernal pools and slow running streams to breed. Even roadside ditches have become breeding waters for this colorful and secretive amphibian. Open water may not be a prerequisite for the annual nuptial dance, however, since spotted salamanders have been seen swimming under a thin film of ice. The salamanders remain at their mating spot for 1–2 weeks; then, just as quickly and quietly as they arrived, they leave the pools and resume their relatively inactive lifestyle, well hidden in moist, dark burrows.

**DESCRIPTION:** Adult spotted salamanders are gray brown to blue black, with a light gray blue venter. Two irregular rows of large, bright yellow to orange spots run down the back of either side of the mid-dorsal line; these readily distinguish the spotted salamander from any other Maine salamander. The number of spots varies from 24–45 (Bishop 1941). As with other closely related salamanders, spotted salamanders have four toes on the front feet, and five on the hind.



In New York, adult males range in length from 15 to 19.6 cm (6–7.75") and are usually a little longer and more slender than females, which average around 17 cm (6.5") (Bishop 1941). Data from Nova Scotia, however, indicate that females average slightly larger than males (Gilhen 1984). The reason for this size discrepancy is not known. During the breeding season, the sexes can also be distinguished by color. The venter of the female turns a lighter pale slate color, while the male's colors are heightened, with his spots becoming brighter (Bishop 1941). The male may also be recognized during breeding season by a greatly swollen and protuberant vent. Hatched larvae are dull greenish yellow, 1.2–1.3 cm (.5") long, and have long, fringed gills. The forelegs are merely elongated buds, without toes. Small appendages on each side of the head in front of the gills serve as "balancers" to aid the larva in maintaining its position as it swims and feeds.

**DISTRIBUTION AND STATUS:** Spotted salamanders occur statewide, but seem to be most abundant in the mid-state region and largely absent from the western and northwestern sections of Maine. Because it is seldom seen except on rainy nights in early spring, the species may have been overlooked in these areas, thus it may be more widely distributed than current data suggests.

**HABITAT:** The spotted salamander is a member of the family Ambystomatidae, the mole salamanders. As the name suggests, mole salamanders are characterized by burrowing habits and typically occur in areas with suitable substrate for digging.

Spotted salamanders seem to prefer deciduous or mixed mesic woods in which there are slow streams or vernal pools. Vernal pools, small temporary ponds that form in depressions from snow melt or spring rains, most likely are preferred habitat due to the absence of fish, which prey on eggs and larvae (Clark 1986).

Spotted salamanders are nocturnal and spend most days under leaves, rotting wood, stones, or in underground burrows. Semlitsch (1983) studied the burrowing ability of mole salamanders and discovered that spotted salamanders do not actively dig their own burrows, but exploit cracks, crevices, and invertebrate or small mammal burrows. This passive burrowing is accomplished by using the snout and body to enlarge already existing burrows. Spotted salamanders did not attempt to burrow if there were no cracks or crevices already present in the substrate (Semlitsch 1983).

To hibernate spotted salamanders burrow beneath leaf mold or stumps, or burrow down into the ground in winter. The increase in temperature and humidity of coming spring will end hibernation and signal the start of migration to the breeding pools.

**REPRODUCTION:** Migration to the breeding pool occurs on warm, humid, rainy, cloudy, or foggy nights, usually in mid-March to early April. Males head to the breeding sites first, with the females following a few days later. A mark-recapture study conducted by Whitford and Vinegar (1966) showed that spotted salamanders in Rhode Island were able to locate the pools in which they were born from as far away as 120 meters (420'). Shoop (1965) also suggests that spotted salamanders will return to natal breeding ponds.

When the adults reach the breeding pools, they engage in a nuptial dance. Male and females rub and nudge each other, first with their snouts, then with the rest of their bodies. Considerable intertwining and wrestling takes place "making the water fairly boil" (Bishop 1941). In the later stages of the dance, the male nudges the female with his nose, while she remains passive. He then deposits white, gelatinous spermatophores over the shallow areas of the bottom, each male averaging about 40 spermatophores. The female positions herself over the spermatophores and grasps them within her cloaca, thus allowing internal fertilization to occur. The eggs are held within her body for several days before being laid.

The eggs are laid in a mass, attached to submerged vegetation about 15 cm (6") underwater. Each mass contains up to 200 eggs, but 100–150 is typical. Immediately after deposition, the egg mass is 6–7.5 cm (2.5–3") in diameter, but it quickly absorbs water and expands to over 10 cm (4") in diameter. One female usually lays 2–3 egg masses. The egg mass is clear to milky white and gelatinous. Individual eggs are dark brown or gray above, whitish to yellow below, and 2.5–3 mm (.09–.11") in diameter.

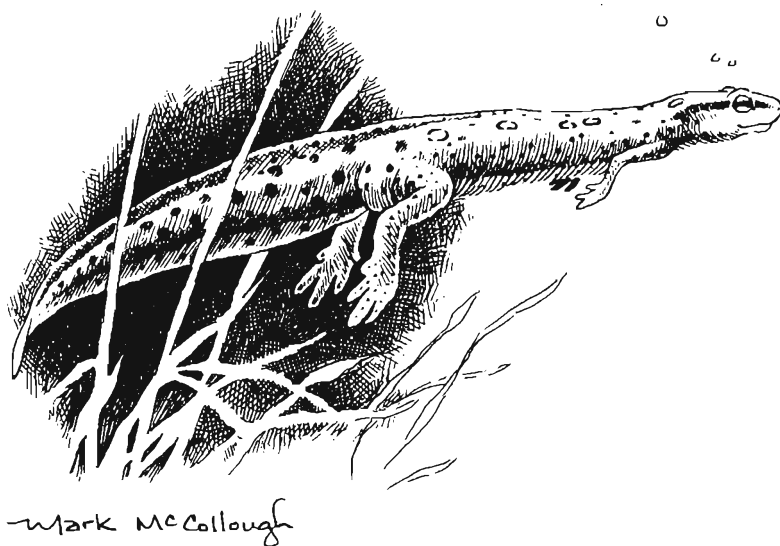
Water temperature is a prime factor determining the hatching period of the eggs. Anywhere between 1–2 months appears to be the norm in the Northeast with temperatures 10°C (50°F) or above (Whitford and Vinegar 1966). Eggs on the outside of the mass hatch first, probably because they receive more light and therefore more heat (Bishop 1941). The situation with frog egg masses is the opposite. Frog eggs are darker than salamander eggs, so the egg mass absorbs heat better, causing the eggs toward the middle of the mass to hatch first. The larval period lasts between 70 and 100 days (Whitford and Vinegar 1966), at which time the larvae have transformed into miniature adults, about 7.5 cm (3") in length. Sexual maturity is reached by the following spring.

**DIET:** Spotted salamanders are carnivorous. Adults have a varied diet, foraging in rotting wood and subterranean tunnels for earthworms, slugs, spiders, snails, millipedes, ants, and larval and adult beetles. Larvae eat small fish, and under crowded conditions, sometimes each other. Cannibalism occurs in both adults and larvae. The absence of food in the stomachs of the salamanders during spring migration and while at the breeding pond suggests that during this time the salamanders do not eat (Bishop 1941).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Most humans have little or no contact with spotted salamanders due to the reclusive, secretive habits of this amphibian. Only during breeding migration are these salamanders readily seen as they cross roads and yards to breeding pools. A great many spotted salamanders are killed by cars when crossing roads. During migration they also fall easy victim to nocturnal predators. Spotted salamanders are preyed upon by fish, raccoons, snakes, skunks, and sometimes other salamanders. Visible signs of this mortality are few during daylight hours because dead salamanders are quickly scavenged by crows, skunks, and other carrion eaters.

The biggest threat to spotted salamanders in Maine, as in the rest of their range, is loss of suitable habitat by destruction of wetlands and woodland pools. Because spotted salamanders return to the same pool for breeding, if it is destroyed, breeding may not occur. In the Northeast, acid precipitation is another potential threat to the species. Permanent lakes or ponds may have a natural buffer system against acid precipitation. Temporary pools, however, are created by snow melt and spring runoff, which tend to have concentrated amounts of acid in the water. There is no chance for dilution of low pH in temporary pools, as is the case with permanent water bodies. Therefore, the eggs must develop in a dangerously low pH, with no chance for acclimation. Maximum hatching results when pH is between 7–9 (Pough 1976). Below that level, mortality rises sharply and is associated with distinctive embryonic malformations such as a curved spine.

Francie Smith, Maine Natural Heritage Program, Augusta, Maine



## EASTERN NEWT

*Notophthalmus viridescens*

Eastern newts are Maine's most aquatic salamander (except for the exotic mudpuppy), and are unusual among our salamanders because they have three distinct stages in their life cycle. Newts are aquatic in the larval stage, then undergo metamorphosis to become terrestrial in the juvenile red eft stage, then return to water as adults. Even more unusual is the fact that in some populations, individuals may skip the juvenile stage, retain some larval characteristics such as external gills, and become sexually mature without ever leaving the aquatic environment. This process, which was described more than 100 years ago, is called neoteny, and these individuals are called neotenes.

The conditions that produce neotenic newts are still a mystery. Although no neotenes have been recorded from Maine, there are reports of neotenic populations from Massachusetts south to Florida and west to Illinois (Albert 1967). It is possible, given the correct environmental and genetic conditions, that neotenic individuals do exist in Maine. The habitats of known neotenic populations are relatively permanent ponds in generally dry and sandy areas of coastal New York (Bishop 1941) and Massachusetts (Healy 1974). In Illinois neotenic individuals occur in farm ponds separated from woodlands by large grassy areas (Albert 1967). In general, these are considered marginal habitats for efts and adults, and this may explain the

existence of neoteny. Perhaps in poor environments, it is advantageous to reduce the time to sexual maturity from 4 to 2 years, and thus facilitate population growth, particularly in recently colonized areas (Healy 1974).

**DESCRIPTION:** Adult newts are medium-sized salamanders averaging 8.5–9 cm (3.4–3.6") total length, although larger individuals 12.4 cm (4.8") have been found. The color varies from olive green to greenish or yellowish brown, with scattered flecks and spots of black, and a series of red spots with black borders along either side of the mid-dorsum. The lower half of the body and limbs varies from light to bright yellow with black flecks and spots. The skin of aquatic adults is very smooth, and the tail develops a thin wavy keel, especially in males during the breeding season.

Larvae are found from late spring through the summer. They have a keeled tail and external gills just posterior to the head. They are light yellow to yellowish green with flecks or bands of gray or brown pigment above, and pale yellow without flecks or spots on the belly. At the end of the first summer, as the larvae undergo metamorphosis, the gills become smaller and finally disappear, and the skin and body shape take on the characteristics of the terrestrial eft stage, except in neotenic individuals. Neotenic newts retain external gills (although they may be small) and very smooth skin, and generally have a more drab larval coloration than that of metamorphosed adults.

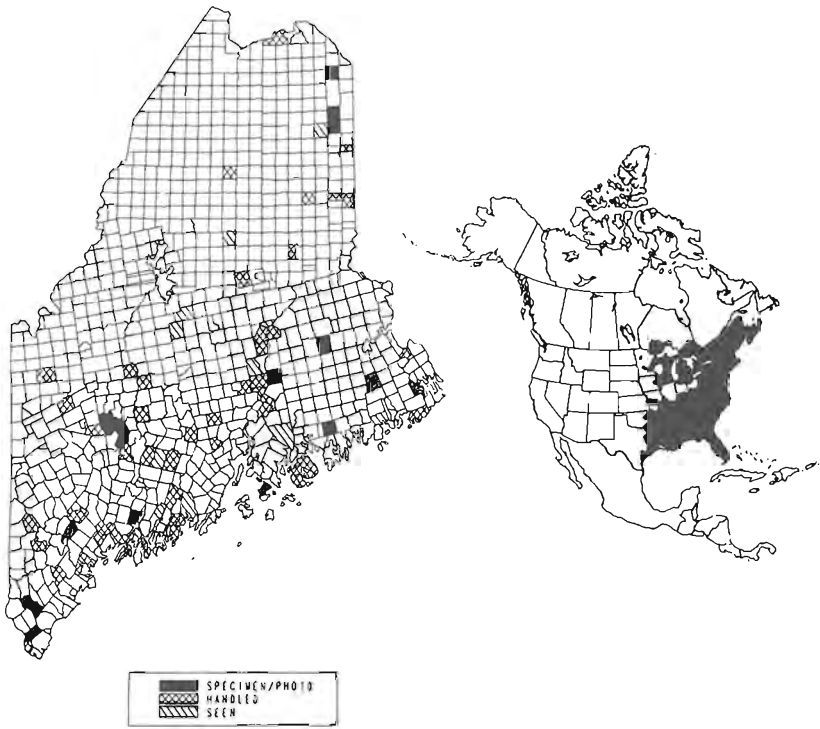
Efts are generally red in color, but vary considerably from dull reddish brown through shades of reddish orange to bright red. They also have black flecks and spots and red spots with black circles on the back. The skin of efts is dry and rough to the touch. The tail is almost round in cross section. Efts spend two to seven years in a terrestrial habitat (Healy 1974) and then, over several months, become sexually mature, return to an aquatic environment, and take on adult characteristics, such as a keeled tail.

**TAXONOMIC STATUS:** Newts in the Northeast are usually known by their subspecific name red-spotted newt, *Notophthalmus viridescens viridescens*.

**DISTRIBUTION AND STATUS:** Newts have been recorded from every county of Maine. Fewer populations have been found in northern and western areas, but this may be due to the difficulty in surveying these areas rather than actual gaps in abundance. The range also extends throughout the Maritime provinces. Although no neotenic individuals have been found in Maine, it is possible that they exist.

**HABITAT:** Adults are found in relatively permanent ponds in woodlands, gravel pits, farm fields, orchards, mountains, plus quiet areas of streams, and shallow areas of lakes. They are seen most often in areas with soft bottoms and vegetation, although they can also be found in areas with sandy, gravelly, or rocky bottoms. (Adults have also been seen swimming under ice





during winter months.) Newt larvae are found in these aquatic areas until they transform into juvenile eft.

Efts are found in woodland habitats (deciduous, coniferous, and mixed), usually in the same general areas where adults breed, although efts do migrate. These terrestrial individuals are found most easily after summer rains when they emerge from hiding places under logs, bark, rocks, or discarded boards, etc. Adults have also been found in terrestrial habitats, especially when shallow ponds have dried up, or the water temperature rises too high, or oxygen concentration decreases too much. They may migrate to nearby ponds or stay in moist areas under protective shelters.

Newts migrate during the spring, summer, and autumn (Hurlbert 1969). Sexually mature efts can be found migrating to aquatic areas during any of these seasons. Larvae undergoing metamorphosis into efts can be found emigrating from hatching ponds into the terrestrial habitat in late summer and autumn. Individuals usually migrate at night during periods of rainy weather.

**REPRODUCTION:** Newts breed in aquatic habitats during the spring months. Breeding males develop thick black ridges on the inner surface of the hind legs and the vent appears very large and protuberant. A male grips a female with its hind legs, just behind the head of the female. The male then rubs the snout of the female with the side of his head and fans the water near

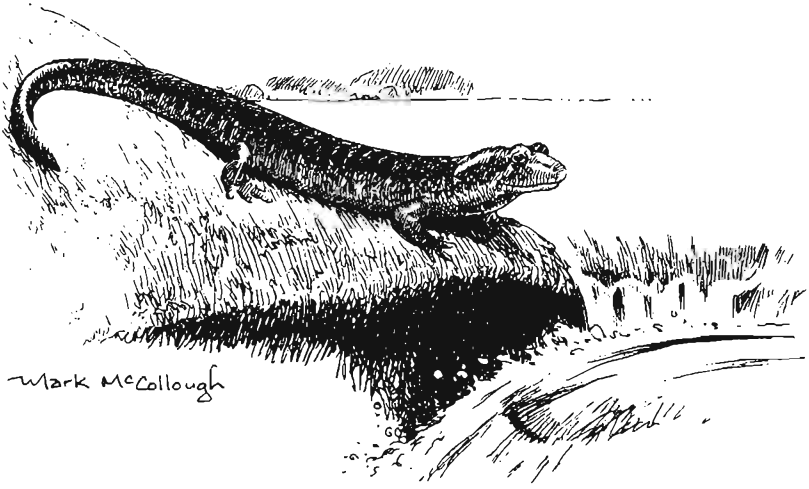
her head with his tail. The male may maintain this position for an extended period, up to several hours, then dismount the female and walk in front of her and deposit sperm inside a spermatophore on the bottom of the pond or stream. The female follows the male, passes over the spermatophore until it touches her vent, then picks up the sperm packet with her vent. The female retains the sperm inside her cloaca until she deposits single eggs. (The number of eggs within the female's ovaries varies from 80–450, depending on the individual.) The deposited eggs are attached to aquatic vegetation, either to stems or wrapped in leaves. The eggs are small, about 1.5 mm (1/8") diameter. Eggs require about a month to develop; warm water speeds development and cold water slows development.

**DIET:** Newts are carnivorous, preying almost entirely on invertebrates. During the larval stage, prey include ostracods, copepods, amphipods, water fleas, insect larvae, pea clams, and snails. Efts and migrating terrestrial adults prey upon springtails, spiders, mites, worms, and snails. Aquatic adults prey upon various aquatic insect larvae, including midge and mosquito larvae and nymphs, water boatmen, snails, pea clams, frog and salamander eggs and larvae (including their own species), and occasionally small minnows.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Most amphibians are vulnerable to predation by a sizable array of larger animals, but newts may be able to deter some potential predators as a result of the toxic secretions in their skin (Hurlbert 1970). Apparently these toxins do not harm humans who handle them. One characteristic of newts that may be significant to humans is their tendency to feed on midge and mosquito larvae, thus reducing the numbers of these pests.

Enoch H. Albert, Readfield, Maine





## DUSKY SALAMANDER

*Desmognathus fuscus*

Variability is the hallmark of the dusky salamander. Individuals have different color patterns which may change and darken as the salamander ages. Further complicating the task of identification, dusky salamanders are our most nondescript amphibian; vague adjectives like “dark” and “brown” are often foremost in the description of a dusky. In some states, numerous other members of the genus *Desmognathus* add to the confusion, but in Maine identification is much easier because we have only one species of this genus. Its narrow range of habitats also simplifies identification; the dusky is a stream dweller, hiding under rocks and logs in wet substrate by day and foraging along the water’s edge at night.

**DESCRIPTION:** Adult dusky salamanders are 6–11 cm (2.5–4.5”) long. Dusky often appear all dark brown, even black, when first seen in the limited light of a dark stream bank on the shady forest floor. However, in good light typical individuals show interesting mottling. Exceptions do occur, but the typical dusky is darker on the back with a scalloped black edging to the dark dorsal band. The sides below this edging are a lighter brown. The larvae are dark with pairs of white or light spots in a gray dorsal band. Gills are short and white.

Dusky get darker with age, and an older and larger individual will

typically appear less distinctly marked and mottled than a younger, smaller one. Lower sides are finely flecked giving a salt-and-pepper effect; the venter is light gray. Most individuals have 14 costal grooves. The tail has a slight keel or ridge on top. Their hind legs are significantly stouter than those in front, a unique feature among Maine salamanders and thus a useful characteristic in distinguishing a dusky from other species. Duskyies also are much stouter-bodied than the two-lined salamanders often found in the same habitat. Another reliable clue is a light line that goes diagonally down and back from the eye to the back of the jaw.

Females are smaller than males; their snout is more round, and the sides of the head behind the eyes are roughly parallel. Males have a slightly more pointed snout, and the head behind the eyes appears more swollen.

**TAXONOMIC STATUS:** At the subspecies level, the duskyies in Maine are *Desmognathus fuscus fuscus*, the northern dusky salamander.

**DISTRIBUTION AND STATUS:** The dusky salamander appears to range throughout most of Maine, although its occurrence seems to have gaps such as in eastern Maine. These apparent gaps may only reflect the dusky's being harder to find compared to the more common and widespread two-lined salamander.

**HABITAT:** Dusky salamanders inhabit the moist edges of woodland streams, and springs and seeps in forested areas. They can be common along rocky, high-gradient, forested brook headwaters, where they hide under rocks and logs in the oxygen-saturated water's edge, often in the company of two-lined salamanders. However, duskyies appear to tolerate a narrower range of water temperature and quality than two-lined salamanders and are not usually found in warmer, muddier streams of open or disturbed areas (Markowsky unpubl. data). Like the other plethodontids, they have no lungs and absorb oxygen through their moist skin and membranes in the throat.

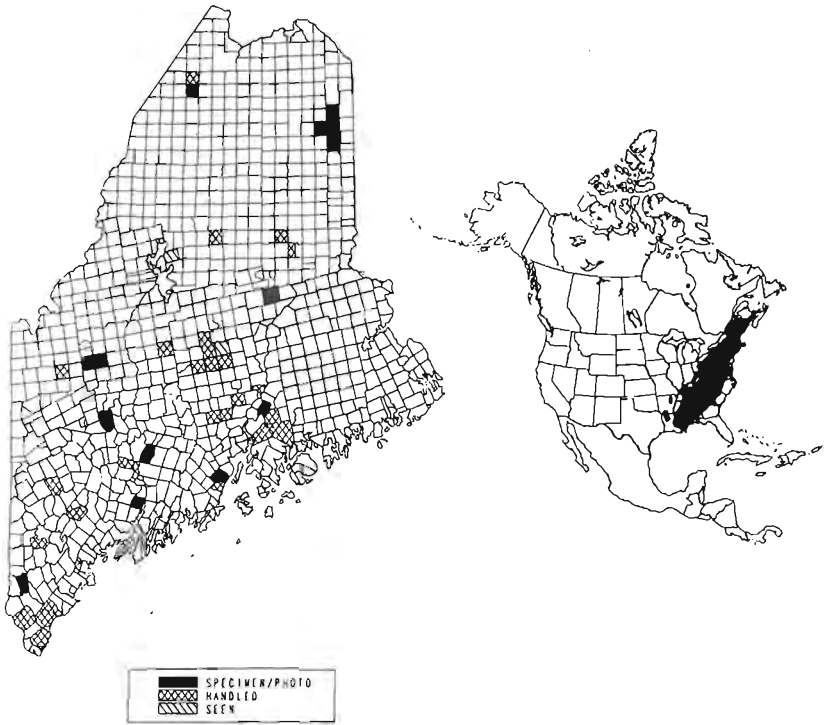
Duskyies winter in underground retreats near streams, 30–50 cm (10–25") below the surface, and where groundwater moves through the substrate, they may remain active all winter (Ashton 1975).

**REPRODUCTION:** Breeding may occur in fall, winter, or spring. Courtship consists of the male rubbing his head or side against the snout of the female. She then walks behind the male, her snout pressing the base of his tail which he undulates from side to side. Eventually he deposits a spermatophore which she picks up in her cloaca.

Eggs are laid in the summer; the female hollows out a retreat in damp substrate within 50 cm of a stream, usually under bark, a log, a rock, or damp moss. Eggs (10–30) are laid and guarded by the female who encircles the clutch with her body, remaining with the eggs until hatching. Eggs are white and opaque when first laid; the incubation period is 7–8 weeks.

Within several days of hatching, the larvae work their way through

## Dusky Salamander



wet substrate to the stream. Larvae are entirely aquatic, living in the shallow stream water and substrate through the fall, winter, and spring. They emerge the following summer as small adults about 3 cm (1.3") long.

**DIET:** Adults hunt at night and feed on any small terrestrial or aquatic insects, worms, crustaceans, spiders, molluscs that they can capture and eat. Larvae are similarly eclectic in their eating habits, taking small copepods, insect larvae, and tiny clams.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Dusky salamanders are eaten by spring salamanders. Other Maine streamside predators are raccoon, skunk, otter, mink, and spotted sandpiper.

Because dusky salamanders prefer cooler brooks, removing streamside cover could degrade their habitat. One could speculate that acid deposition may not directly affect dusky salamanders as much as *Ambystoma* salamanders because dusky salamanders lay eggs in moist terrestrial microhabitats. Further, the major acid pulse of the season, snowmelt and spring runoff, occurs prior to egg laying and when the previous season's larvae are nearly mature. Acid deposition, however, may affect dusky populations generally by reducing forest and stream productivity.

Juliet Kellogg Markowsky, University of Maine and Maine Audubon Society



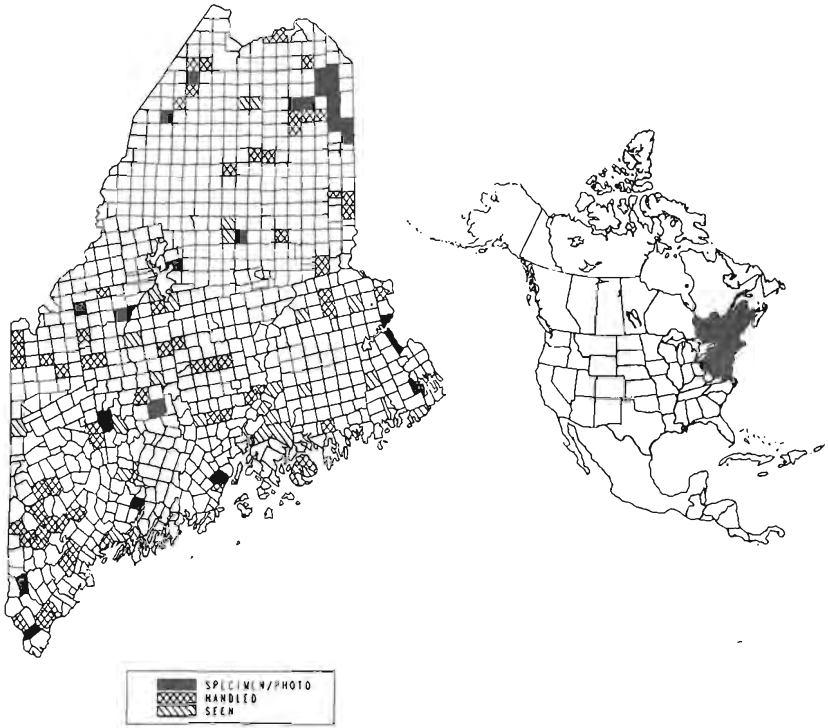
## TWO-LINED SALAMANDER

*Eurycea bislineata*

The two-lined salamander is the smallest, most abundant, and most widely distributed of the three "brook salamanders" (two-lined, dusky, and spring salamanders). Two-lined salamanders are so abundant they can be found in virtually every stream, rocky seep, and watershed in Maine. They are extremely active. When their cover rock is turned over, two-lined salamanders dash away, not using their legs, but rather wriggling and undulating like a tiny snake into the water or under another rock.

**DESCRIPTION:** In the hand, a two-lined salamander will show a yellowish venter and back and two dorso-lateral dark stripes, one on each side starting behind the eye and continuing along the sides and tail. Its legs are tiny, with hind legs appearing about the same size as those in front. The tail is keeled, that is, there is a ridge along the upper edge of the tail, an aid in swimming.

Average length of adults is 7–9 cm (2.8–3.6"). They are the smallest and slimmest-bodied of the three streamside species and, like the others, have no lungs, breathing through moist skin and through membranes in the mouth and throat. Larvae are 1.2 cm (.5") long when first hatched, and up to 6.5 cm (2.5") at metamorphosis. Larval two-lined salamanders have a double row of paired light dorsal spots on a reticulated background. Gills are small and lightly pigmented; the gills of larval dusky salamanders are white.



**TAXONOMIC STATUS:** Maine's two-lined salamanders are the subspecies *E. b. bislineata*, the northern two-lined salamander.

**DISTRIBUTION AND STATUS:** They are abundant statewide in virtually every Maine stream and watershed.

**HABITAT:** Two-lined salamanders are common at the edge of even the smallest permanent brooks, but also occur along shorelines of our largest rivers. Small brooks edged with flat rocks about 15 cm (6") across are the easiest habitat in which to find them. In such habitat, many of the rocks half in and half out of water will be cover for one or several two-lined salamanders. They can also be found under rocks or logs in other rocky, wet areas such as springs and lakeshores.

Many adults move away from streams on rainy evenings just after the breeding season, and recently metamorphosed young disperse from streams in August. Considerable mortality occurs during these overland trips; only 25% return to the stream in September (MacCulloch and Bider 1975).

Because of this dispersal behavior, two-lined salamanders are relatively quick to recolonize brooks after a disturbance. They are often the only species found in warmer streams exposed to the sun, since they can tolerate a wider range of temperature than can the dusky or spring salamanders (Layne and Claussen 1982). Two-lined salamanders are active through the

winter and feed in moist, unfrozen substrate underground near brooks (Ashton 1978). They have also been found feeding actively under rocks in brook water in winter.

**REPRODUCTION:** Courtship and mating occur in the fall, winter, or early spring. In courtship, the male pushes his snout against the female and then arches his neck and head around her snout. The female then straddles the male with her front legs around his body above his hind legs. During this "straddle walk," the male bends his tail first to one side, then to the other, while the female bends her neck and head to the opposite side. Then the male releases the spermatophore which the female picks up with her cloacal lips and stores in her cloaca.

In spring or early summer the adult female individually cements each of 12–36 stalked eggs in a cluster to the underside of a rock in the flowing water of a very small brook where predatory fish are absent or scarce.

Hatching time may be longer in cold water, shorter in warm water. Larvae hatch in late spring or summer and eat tiny arthropods and worms in the stream water and substrate. A netful of stream-bottom silt, gravel, or leaves will frequently have several larval two-lined salamanders in it. First-year larvae are weak swimmers and many wash downstream. Of these, few survive to become second-year larvae or adults (Bruce 1986). Larvae typically metamorphose into adults two years after hatching, sometimes three, possibly depending on food availability in the stream.

Branched, external gills of brook salamander larvae (two-lined, dusky, spring salamanders in Maine) are considerably smaller than gills of salamander larvae that live in more stagnant water such as blue-spotted and spotted salamanders. This is because brook water is more highly oxygenated and less gill surface area is needed.

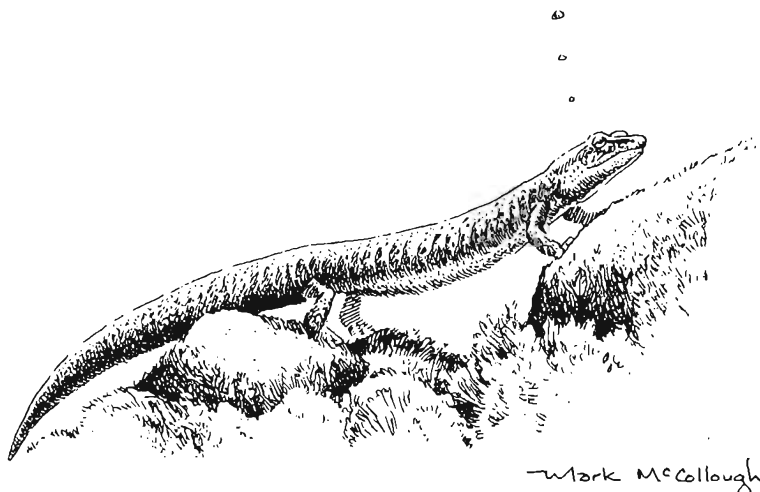
**DIET:** Most prey species of adult two-lined salamanders are terrestrial invertebrates found incidentally at the edge of the brook: insects, spiders, millipedes, sowbugs, mites, and worms (Burton 1976). Larvae eat tiny arthropods, worms, and molluscs in the stream water and substrate.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Spring salamanders and larger dusky salamanders eat two-lined salamanders. Other predators of adults or larvae are raccoons, sandpipers, waterfowl, and fish. People use adult two-lined salamanders as bait for bass fishing.

Two-lined eggs may be sensitive to acidic conditions. However, their egg-laying time is after the spring snowmelt and runoff, and therefore after the major acid pulse of the season, perhaps mitigating some effects of acid deposition on this species.

Juliet Kellogg Markowsky, University of Maine and Maine Audubon Society





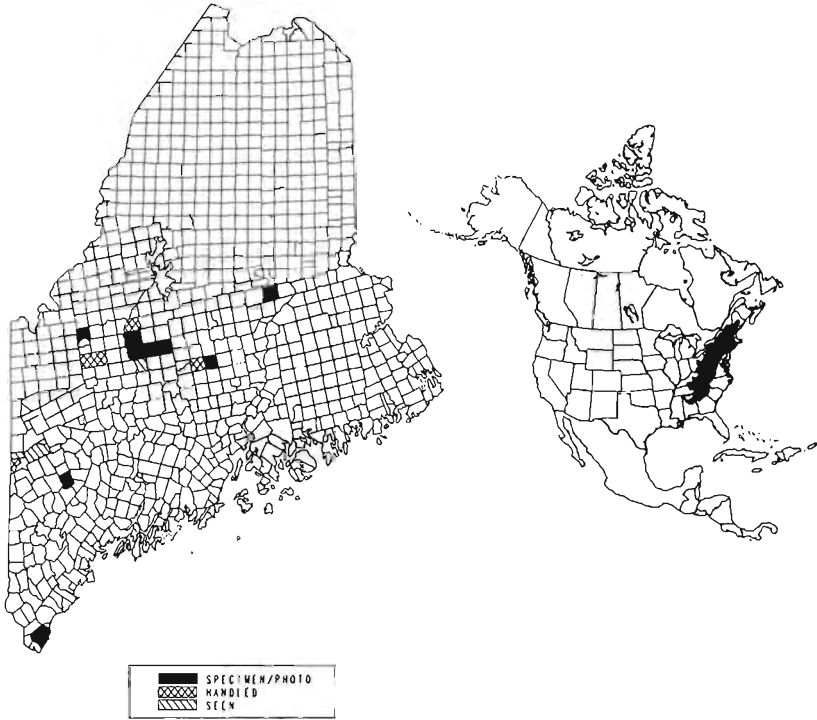
## SPRING SALAMANDER

*Gyrinophilus porphyriticus*

Spring salamanders are the largest, brightest colored, and least common of Maine's streamside salamanders. Their large, muscular, finned tail enables them to swim in swift mountain streams where they hunt among rocks and eddies. They are large and powerful enough to capture and eat the two-lined and dusky salamanders that also inhabit the stream's edge. Spring salamanders are limited to the coolest habitats: well-shaded or spring-fed mountain streams. Even in cool, clean, well-oxygenated streams, however, they are uncommon compared to dusky and two-lined salamanders.

**DESCRIPTION:** Adult length is 12–19 cm (4.75–7.5") and females average smaller than males. The background color of the skin is salmon pinkish orange, with darker net-like mottling on the sides, back, and tail. A light line bordered with gray begins at the eye and curves down over the nose and through the nostril. The tail has a prominent, knife-like keel on the top, an aid in swimming for this aquatic salamander. Costal grooves are conspicuous, with most individuals having 17. The venter is flesh colored. Larvae have a finely reticulated pattern like that of adults, and a proportionately larger head compared to the larvae of dusky and two-lined salamanders.

**TAXONOMIC STATUS:** Maine's spring salamanders belong to the subspecies *G. p. porphyriticus*, the northern spring salamander.



**DISTRIBUTION AND STATUS:** Prior to MARAP, the spring salamander was known only from the western Maine mountains, with old records as far east as the Kennebec River. This species is now known to range from southern York County north and east as far as central Penobscot County in the Penobscot River drainage. Although moderately common in some streams, it is generally far outnumbered by dusky and two-lined salamanders.

**HABITAT:** Spring salamanders are found typically in cold, clean, undisturbed, high-relief mountain streams, but also in less steep, cool seeps and springs in forested areas. During the winter they remain in wet, unfrozen substrate or burrows near, in, or under brooks, where they may remain active all winter.

Their association with cool, well-oxygenated habitat may be related to their anatomy. Like the other plethodontid salamanders, spring salamanders have no lungs; their oxygen needs are met by absorbing oxygen through the moist skin and the membranes in the throat. Because spring salamanders are large, they have a proportionately small surface area, relative to their mass, over which to absorb oxygen. Therefore, they are restricted to only those streams with an ample oxygen supply.

**REPRODUCTION:** Mating season is in the fall, with egg-laying in the spring and summer. During courtship, male and female engage in an

amorous pushing match accompanied by much rolling around in the water. The male subsequently deposits a spermatophore which is picked up by the female. The sperm are stored in the female's cloaca until eggs are laid. Eggs are cemented one at a time under a stone, or sometimes a log, in running water. The female, while upside down in the water under a stone, presses her cloaca against the stone and extrudes the egg, which adheres where it is pressed. The resulting compact cluster may contain anywhere from 10–160 eggs, but 40–60 is most typical. Eggs hatch in late summer or early fall.

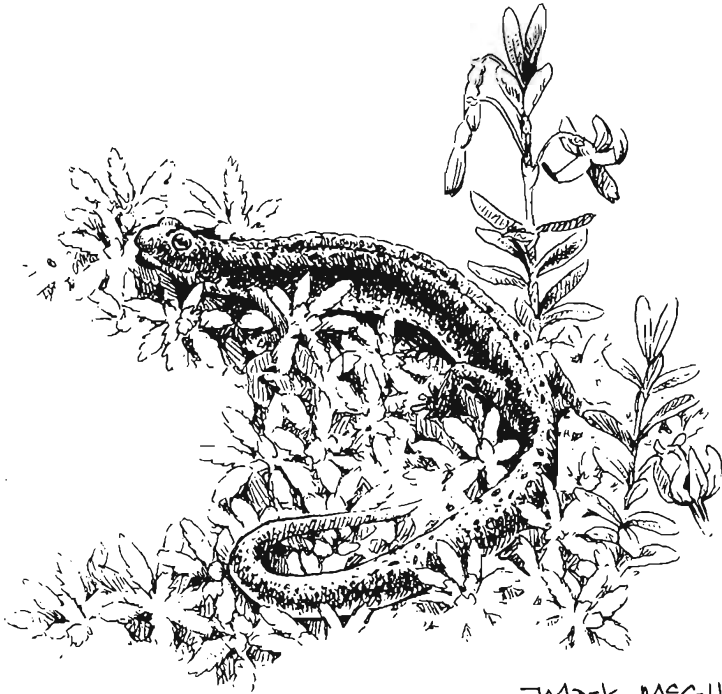
The aquatic larval period is variable but averages four years. Larvae are 2.6–2.8 cm (1") long when first hatched and 10.5–12.5 cm (4–5") long at metamorphosis, which occurs in late spring and summer.

**DIET:** Adult spring salamanders eat other small salamanders and frogs, millipedes, earthworms, spiders, snails, centipedes, and crustaceans. Larvae eat aquatic arthropods, worms, and molluscs. In northern New Hampshire, spring salamanders eat primarily terrestrial insects that occur at brooks' edges incidentally (Burton 1976). In New York, other salamanders (dusky and two-lined) constitute a minor part of their diet (Bishop 1941).

It has been speculated that the diet of spring salamanders, particularly the consumption of other salamanders, may be related to other aspects of their life history (Bruce 1972). In the Carolinas, almost half of the spring salamander's diet consists of other salamanders. In southern streams, spring salamanders are scarce, and Bruce (1972) suggested that this may be due to their high trophic level position as a top predator. He suggested that in high-elevation, undisturbed streams, spring salamanders have the low reproductive rates of an animal that lives at a high trophic level in a stable environment. Bruce (1972) also found that in the southeastern edge of its range, at lower elevation streams where disturbances have probably subjected them to localized extinctions, spring salamanders appeared to have the higher reproductive rates of a population that exists at a lower trophic level in an environment characterized by disturbance. The tentative conclusions of this study might apply in Maine where spring salamanders are also at the edge of their range. Here they may feed at a lower trophic level and lay more eggs and mature more rapidly than in the central portion of their range. Such a hypothesis has yet to be tested.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Spring salamanders are uncommon and seldom encountered by people. Their typical habitat is steep mountain streams, but they also occur in stream systems where logging and development can occur. Acid precipitation may have minimal effect on this species, since egg deposition and larval development occur after the major acid pulse of the season snowmelt, and spring runoff. Mainstream predators that may occasionally take spring salamander adults or larvae include raccoons, mink, otter, and predaceous fish.

Juliet Kellogg Markowsky, University of Maine and Maine Audubon Society



Mark McCollough

## FOUR-TOED SALAMANDER

*Hemidactylium scutatum*

Prior to the Maine Amphibian and Reptile Atlas Project, the diminutive four-toed salamander claimed the dual titles of Maine's least known and smallest amphibian. In the late 1930s, a George Washington University biologist reported a single four-toed salamander from the YMCA camp on the shores of Lake Umbagog (Fowler 1942). This remained the only known specimen in Maine for about 20 years until a second one was found in 1958 at Salisbury Cove on Mt. Desert Island. It was 1976 before the third was found in the town of Dedham and the fourth in Old Town (Burgason and Davis 1978). Nevertheless, many herpetologists expected it to be more widespread, due to its known occurrence south of Maine and in Nova Scotia to our east, and considered Maine simply a gap in our knowledge, not a gap in the four-toed's range. So it was not surprising that during the first 3 years of MARAP, the number of towns with documented records for four-toeds tripled from 4 to 12. Even though four-toeds can no longer be considered a great rarity, they are still Maine's smallest terrestrial vertebrate and our most difficult to find amphibian. That is a claim no group of herpetologists snooping through the bogs on rainy nights is likely to take away from them.

**DESCRIPTION:** Four-toed salamanders are easily identified by three distinctive characteristics. First, as its name implies, this salamander has only four toes on the hind feet, unlike most of the plethodontid salamanders which have five. (Maine's only other "four-toed" salamander is the exotic mudpuppy.) Second, the tail has a very distinct basal constriction. This is generally where the tail will break off when the salamander is grabbed by a predator. Third, the belly is like a bright white enamel speckled with black.

The dorsal coloration is reddish brown, fading to a gray or almost black color along the sides with the white belly covered with black speckles the size and shape of coarsely ground pepper. The larvae have a keeled tail that is continuous with the back keel—a unique condition among plethodontid salamanders. A short, wide, dark bar on the side of the head joins the eye and gills.

The males vary from 5–7.6 cm (2–3") in total length, averaging 6.5 cm (2.6"). Females are slightly larger, varying from 6.2–8.9 cm (2.8–3.5") and averaging 7.5 cm (3"). The head of the female is described as broadly rounded versus the squarely truncate shape of the male.

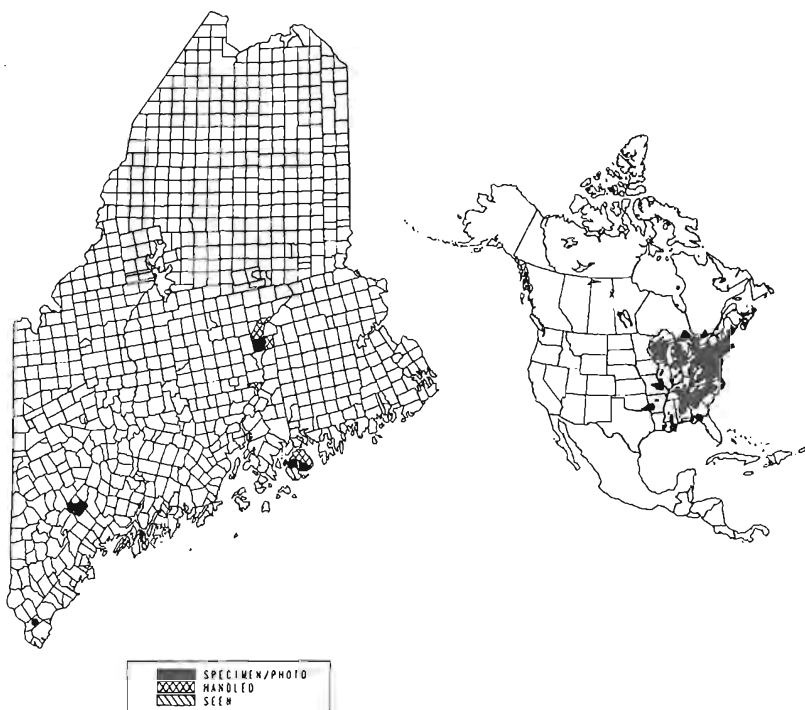
**DISTRIBUTION AND STATUS:** The currently documented distribution for the four-toed salamander reveals three clusters of locations. The first cluster is along both sides of the Penobscot River, extending from Dedham north to Mattamiscontis. The second area is Mt. Desert Island where four-toeds are documented in two of the four towns on the island. The third area is the southern part of Lincoln and Sagadahoc counties. It would require considerable work to determine whether four-toeds are absent, rare, or just hard to find in various parts of the state.

**HABITAT:** The single common habitat element noted by herpetologists from throughout the four-toed's range is wet moss, usually sphagnum moss. The adults are terrestrial and are generally associated with forests in or adjacent to sphagnum bogs, or forests with sphagnum dominated depressions in them. The four-toed takes refuge in the wet moss, under fallen objects, and in rotting wood. The aquatic larvae are found in small ponds and slow moving streams running through bogs and wet mossy areas.

These salamanders hibernate in and under rotting wood and leaves as well as in the channels of decaying tree roots. Most reports indicate a tendency of four-toeds to clump together in small to rather large groups to hibernate. One report from southern Michigan (Blanchard 1933) details a hibernation site of just a few square meters where nearly 200 four-toeds were found under the leaf litter, and in association with 114 spring peepers, 83 swamp tree frogs, 8 wood frogs, and smaller numbers of Jefferson salamanders, redback salamanders, and red-spotted newts.

**REPRODUCTION:** The breeding season for this species lasts from late summer (early August) through fall (October). In Virginia, Wood (1953) felt that salamanders reached sexual maturity during their third year. There is

## *The Amphibians and Reptiles of Maine*



a brief courtship that consists of the male rubbing his snout, lips, or the side of his body against the female's snout. Sperm are then transferred to the female by means of spermatophores, small packages of sperm which are deposited on the substrate and then picked up by the female and held in her cloaca. Spermatophores for the four-toed salamander are 2 mm high.

The eggs are laid the spring following mating in mid- to late April and extending into June, depending on local climatic conditions. The eggs are laid singly, but adhere in a cluster; the number of eggs per clutch varies from 19 to 50. Eggs are laid in cavities within a clump of moss or grass overhanging water. Females will often attend their eggs until hatching, although the value of this behavior is debated. Moreover, several females will often lay their eggs in close proximity to one another, in which case only a few of the females will attend the eggs. One such communal nest site in Virginia contained 868 eggs (Wood 1953). The larvae are about 1.2 cm long when they hatch after an incubation period of 38 to 60 days. They then wriggle until they drop into the water. The larvae grow to 1.8–2.5 cm (.75–1.0"), transform into adults, and return to land, all during an approximately 6-week period.

**DIET:** The four-toed salamander's diet has been studied little, but the following prey have been noted: ticks, spiders, springtails, midges, ground beetles, rove beetles, fly larvae, parasitic wasps, ants, snails, and true bugs.

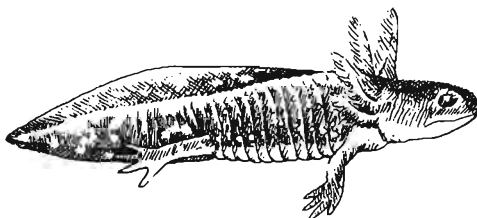
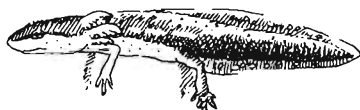
**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** No direct interaction apparently exists between the four-toed salamander and humans. Indirect interaction would include destruction of the salamander's habitat by development, road construction, and timber harvesting in and around boggy wetlands, peatlands, and forested wetlands. The first two would result in permanent destruction, and the last, a temporary change until a forest canopy could be reestablished to provide cooler temperatures on the forest floor.

It may be speculated that, unlike other salamanders whose reproduction has been adversely affected by acid precipitation, the four-toed may have some tolerance to this human insult. Given the four-toed's preference for nesting sites in bogs with sphagnum moss—an acidic environment to begin with—acid precipitation is less likely to affect significantly the four-toed's reproductive capabilities.

The four-toed does not have any specific natural enemies that seek it out, but would certainly be considered prey by larger predators with which it shares its habitat such as shrews, moles, snakes, and larger salamanders. One of Maine's four-toed records was a "half-eaten" individual discovered in a pitcher plant. The accidental demise of this individual is interesting, but probably does not reflect a significant cause of mortality.

Barry N. Burgason, Enfield, Maine

SALAMANDRIDAE - Newt

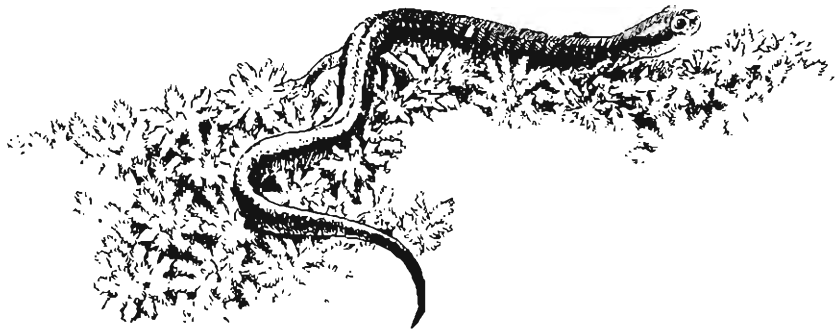


AMBYSTOMATIDAE  
- Spotted salamander

PLETHODONTIDAE  
- Four-toed salamander



*Full-grown salamander larvae.*



Mark McCollough

## REDBACK SALAMANDER

*Plethodon cinereus*

The redback salamander is the most abundant amphibian and probably the most abundant vertebrate animal in Maine. Surface density estimates as high as 10,000 individuals per hectare (almost one per square yard) have been documented at the Holt Research Forest in Arrowsic, and equivalent densities have been found elsewhere in Maine and throughout the redback salamander's range. A study conducted at the Hubbard Brook Experimental Forest in New Hampshire by Burton and Likens (1975), concluded that the biomass of redback salamanders was twice the biomass of birds at peak breeding and equal to the biomass of mice and shrews. These densities suggest that redback salamanders may play an important role in the energy and nutrient cycling of the forest. Despite their abundance, they are seldom seen because of their secretive habits. Nevertheless, they are easily found if sought, and a quick search under logs and rocks in almost any wooded area will usually be successful. One can find them in the forest from spring through fall because, unlike all other Maine amphibians, they are not tied to aquatic habitats; redback salamanders complete their entire reproductive cycle terrestrially.

**DESCRIPTION:** Redback salamanders occur as three distinct color variants: the typical red-back phase and the lead-back phase are both common



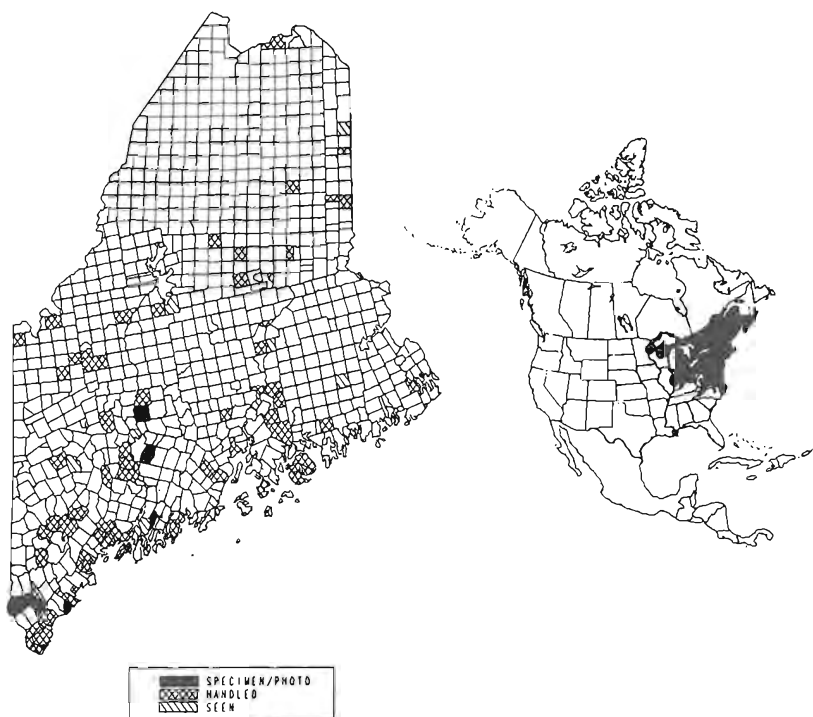
in Maine, although the erythristic or scarlet phase has not been documented. The red-back phase is typified by the presence of a longitudinal dorsal red stripe and dark sides. The stripe can be variable in color from red brown to orange, yellowish, chocolate, and even greenish brown. The back of the lead-back phase varies from dark gray or black to shades of light to dark chocolate brown with graying white or silvery yellow speckling. Both phases have black and gray mottled bellies that give a salt and pepper effect. Erythristic phase individuals are entirely red (pinkish orange to red orange) except for their creamy white venter and black blotches on the distal portions of their tail; they have not been reported from Maine.

The total length of adults ranges from 5.8 to 9.7 cm (2.25–3.82"). Adult snout-vent length is 3.5 to 5.1 cm (1.38–2.0") (Bleakney 1952), although Kleeberger and Werner (1982) list 3.2 cm (1.26") as the snout-vent length to separate adults from juveniles. Except for size, juvenile redbacks look like adults after they lose their external gills a few days after hatching. Redback salamanders may have 17–20 costal grooves, but usually have 19 and have 7–8 costal grooves between appressed toes (Conant 1975).

Adult females average slightly larger than males. Males are also distinguished by the presence of the mental gland (a prominent large circular gland under the chin), lighter pigmentation, and greater folding of the cloacal wall. Possibly the easiest method for sex determination is the shape of the snout. Males have a square tip, while females have a rounder tip (E. Dawley pers. comm.). Adult females lack the mental gland, have darker pigmentation, and a smoother surface of the cloacal wall. The presence of ovarian eggs seen through the abdominal wall will also distinguish females (Kleeberger and Werner 1982).

Redback salamanders can generally be distinguished from other species by their tail, which is uniformly rounded in cross section. Other characteristics useful for separating redback salamanders include a slender body and equal-sized legs (dusky salamanders have a robust body and larger rear legs), and five toes on the rear feet, and the lack of a basal constriction on the tail (four-toed salamanders have four toes on rear and a basal constriction). The two-lined salamander has a dorso-ventrally flattened tail, only 12–14 costal grooves, and a yellowish belly. A lead-back phase could possibly be confused with a small blue-spotted salamander, but the presence of a nasolabial groove distinguishes the lead-back. An erythristic phase red-back superficially resembles a red eft, but the eft would be completely red with spots, possess rough skin, and have inconspicuous costal grooves.

**DISTRIBUTION AND STATUS:** The redback salamander is both very abundant and widely distributed throughout Maine. The lead-back phase is reportedly most common in coniferous and mixed woods, particularly in coastal areas, and the red-back is most common in deciduous woods. In other parts of its range, the erythristic phase replaces the lead-back in deciduous, highland areas, and these two color phases seldom occur together (Tilley et



al. 1982). At the Holt Research Forest in Arrowsic, the ratio of red-back to lead-back is approximately 3 to 2.

**HABITAT:** The redback salamander is the only entirely terrestrial salamander in Maine and inhabits coniferous, deciduous, and mixed forests. It seems to be more abundant in mature, rather than young, forests and can be found in suburban areas adjacent to woodlands.

Within the forest, the redback salamander can be found in the litter and under a variety of cover objects including loose bark, rocks, and logs. They particularly favor moist decaying logs and stumps. Redback salamanders are seldom seen on the surface of the litter except on rainy nights. During dry periods, they often move to underground holes, seeking moist locations, and become difficult to find in the leaf litter. Population surveys usually involve searching on or in the litter, but the proportion of the total population in the litter at a given time is unknown (Taub 1961).

Redback salamanders apparently spend the winter deep (40–90 cm [15–35"]) in the ground where they will not freeze. They are found in cracks in rocks, along tree roots, and in other small openings and soft spots in the soil. One account from Indiana found them in ant mounds, apparently active and foraging throughout the winter (Caldwell 1975). Several authors indicate that redback salamanders suffer a high winter mortality rate, particularly when no snow falls to insulate the ground (Taub 1961).

**REPRODUCTION:** The frequency of reproduction by redbacks salamanders is still open to question. Redback salamanders studied in Maryland had a biennial egg-laying cycle (Sayer 1966); in Connecticut the cycle was annual (Lotter 1978); and research in Michigan did not answer the question (Werner 1971). Mating may take place from October through April, but usually occurs in October. Sexual maturity is reached at lengths beginning at 3.4 cm (1.34") for females and at 3.2 cm (1.26") for males. Individuals of both sexes are usually sexually mature at the beginning of their third year. It takes nearly two years for eggs in sexually mature females to become viable; breeding occurs when eggs have accumulated sufficient yolk (a diameter of 3.0 mm [0.12"] or more) and are then deposited the following summer (Sayer 1966).

Although there is strong evidence that males mark territories (Simon and Madison 1984), mating apparently needs no specialized locations. During courtship, males deposit stalked spermatophores on the ground, which are picked up by females with their cloacas. The sperm migrates to the cloaca's spermatheca, a modified part of the pelvic gland, which serves as a reservoir for sperm storage (Sayer 1966). Eggs are fertilized within the female just prior to egg deposition, which usually occurs in June and July. From 4–17 eggs may be deposited in small suspended clusters in the cavities of moist, well-rotted logs or stumps. Congregations of females may occur when suitable egg-laying sites are scarce. Larvae generally hatch in August and September after a period of 30–60 days (DeGraaf and Rudis 1986); Banasiak (1974) reported up to 84 days for individuals in northern Maine. Females guard the eggs, defending them from snakes and conspecifics (Bachmann 1984).

**DIET:** Redback salamanders are predators within the litter-soil interface and consume a great variety of foods. In most studies, insects (adults and larvae) constitute the largest volume. These include ants, beetles, hemipterans, homopterans, dipterans, lepidopterans, and other groups. Ants often are the most abundant insect items. Other non-insect prey includes earthworms, millipedes, centipedes, isopods, snails, springtails, spiders, mites, and ticks. Mites were the dominant food item in a study by Burton (1976). Cannibalism is occasionally reported, particularly on immature individuals (DeGraaf and Rudis 1986).

Redback salamanders usually forage in the litter or soil, but on rainy nights may visit the surface to forage and will often climb plants. Jaeger (1978) discovered that redback salamanders foraging on plants could search more easily, had a greater density of larger prey from which to select, and were more successful than individuals foraging in the forest litter.

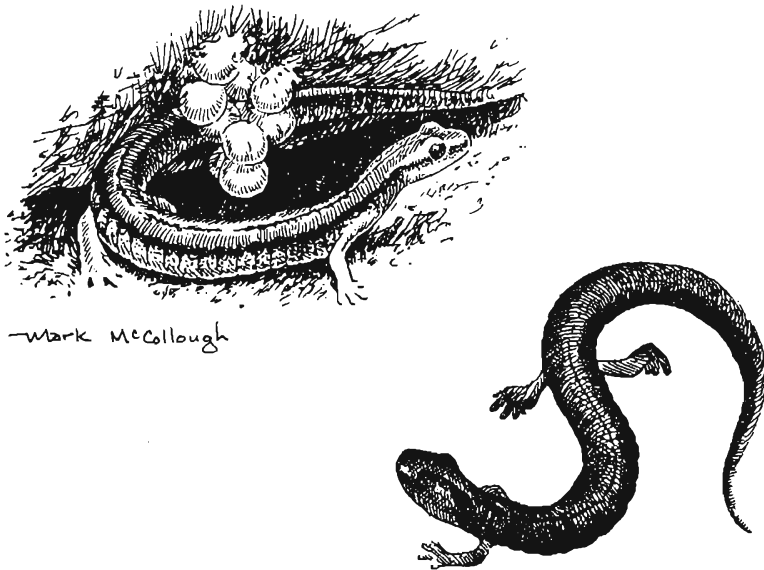
**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Redback salamanders are preyed upon by snakes, birds, and mammals. Four snake species in Maine (ringneck, redbelly, brown, and garter) are known to eat redback salamanders. Snakes are probably the primary predators because

*The Amphibians and Reptiles of Maine*

they share habitats with salamanders more intimately than do birds or most mammals except shrews. Mammals that may prey on redback salamanders include shrews, striped skunks, raccoons, and foxes. Shrews would be expected to be predators, but Brodie et al. (1979) found that redback salamanders are distasteful to shrews.

Bird species known to prey upon redback salamanders include various thrush species, brown thrashers, blue jays, ruffed grouse, and other ground-foraging species. Experiments with caged wild blue jays indicated that they would readily take redback salamanders when given the opportunity (Tilley et al. 1982). It was reported by Coker (1931) that redback salamanders and another species constituted 25% of the food items brought to a nest by hermit thrushes in New York. Jaeger (1981), however, questioned whether birds were important predators on salamanders. He concluded that birds have difficulty separating wet litter where the salamanders are found. Salamanders move out of the litter when it is dry and are generally not available to birds. Redback salamanders are preyed upon by opportunistic predators, but their importance as food for these species is relatively unknown.

Jack W. Witham, Wildlife Department, University of Maine, Orono



*Female redback guarding eggs.  
Lead-back color phase.*



Mark McCollough

## AMERICAN TOAD

*Bufo americanus*

Toads are abundant in Maine and constitute a substantial, but generally inconspicuous, segment of the state's amphibian fauna. They are most frequently encountered during the spring breeding season, when migrating individuals are seen on roads on rainy nights, or choruses are heard in wet areas. After leaving the breeding pools, toads are solitary and seldom seen.

**DESCRIPTION:** The American toad is short-bodied and plump, with a wide, short head and broadly rounded snout. The belly and lower sides are slightly rough and granular. Numerous rounded or spiny warts of varying size occur on the upper sides and back, the largest often in pairs near the dorsal midline. The legs, feet, and especially the thighs are rough and warty. Two cranial ridges on top of the head have lateral branches extending behind the eye. Behind these ridges are the large, bean-shaped parotid glands. The glands are usually separated from the cranial ridges, but may be joined to them by short spurs. Adults range in size from 5–10.8 cm (2–4.2") in snout-vent length. Males measure 5–8.5 cm and females 5.7–10.8 cm.

The general color is plain brown, gray, greenish gray, or nearly black, depending partly upon the season, environment, or time of day. Background colors tend to be lighter, and any markings more distinct, at night. Females

are more likely to exhibit overlaying patterns of dark brown, gray, or black. A light, narrow mid-dorsal stripe may be present. In patterned specimens, irregular dark spots usually surround single warts on the back, or sometimes a cluster of two or three smaller ones. The chest and anterior abdomen may be plain ivory white or sprinkled with small black flecks or spots.

Mature females are substantially larger than males and have a distinctly rougher, prickly feel when handled. Their dorsal warts may be discernibly pointed and tipped with black, red, or orange. The tactile difference and greater girth may aid searching males in identifying females. Breeding males have enlarged pads on the thumbs that are used to grasp the female during amplexus.

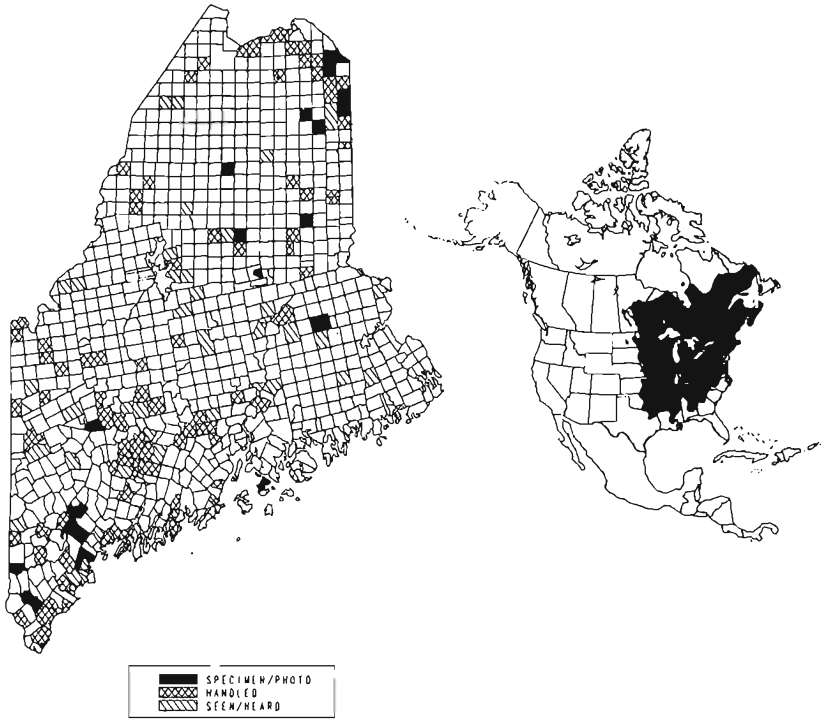
Toad tadpoles are very dark—almost black—even on their venters. They are oval in shape, being broader near their vent than near their eyes, and they have a rounded end to their tails.

**VOICE:** The call is a prolonged musical trill, sometimes sustained for 30 seconds or more. Other callers are often prompted to begin before the initiating singer has finished, resulting in a continuous, pulsating sound. The gray tree frog and spring peeper also trill, but their trills are much shorter.

**TAXONOMIC STATUS:** Most of the toads in Maine belong to the subspecies *Bufo americanus americanus*, the eastern American toad. Specimens matching descriptions of the Hudson Bay toad, *Bufo americanus copei* (Wright and Wright 1949), have been collected in Maine's northernmost Aroostook County (see USNM #266212). These toads are distinguished primarily by their bright, bold colors and markings. The heavy dorsal patterns consist of dark, irregular blotches or bands which contrast sharply with the lighter gray or greenish gray background. Broad (5–8 mm) white stripes bordered by black run mid-dorsally from snout to vent, and diagonally down each side from behind the foreleg to the groin. When seen with a light against a dark background, these stripes stand out as a bright arrowhead shape. Light rose pink coloration is often present in the axillae (armpits). The venter is heavily marked with broad black blotches or reticulations except in the groin. Approximately 36% of toads collected or observed in Aroostook County fit this description (Knox unpubl. data).

Electrophoretic studies of genetic variability have caused taxonomists to question the validity of some subspecies classifications, including that of the Hudson Bay toad. Guttman (1975) concluded that if the most conservative view was accepted, the only populations that could be classified as *B. a. copei* occurred in four localities in extreme northern Quebec. Others, including Cook (1983) and J. P. Collins (pers. comm.), have chosen not to recognize the Hudson Bay toad as a valid subspecies.

Our observations suggest that the most brightly colored toads are found in northern Maine and that their frequency decreases as one proceeds southward. A broad zone may exist in which the distinctively marked



northern forms gradually intergrade with the plainer types of *B. americanus*. A preliminary report on genetic analysis of toads from northern Maine contains some unexpected and intriguing results (J. P. Bogart pers. comm.). None of the specimens in the sample analyzed appear to be classifiable as either American or Hudson Bay toads, but are instead a highly variable (heterozygous) mixture of both. The data imply that initial intergradation occurred long ago, and that subsequent generations have continued to interbreed freely, creating a bewildering array of genetic patterns that may defy any classification.

These findings could certainly help explain the great diversity of colors and markings seen in northern Maine specimens. It would be extremely interesting to know if such genetic diversity also exists in toads from central and southern parts of the state.

**DISTRIBUTION AND STATUS:** American toads are common in Maine.

**HABITAT:** The American toad is virtually cosmopolitan in its habitat requirements. After dispersing from breeding sites, solitary toads may be encountered in open fields, deciduous and evergreen forests, residential yards, urban areas, near lake or river shores, in various kinds of wetlands, or on mountainsides. The only apparent exceptions are saltwater beaches, sloughs, and marshes in tidal range. Preferred breeding sites are in open,

shallow water in temporary pools, ditches, old beaver flowages, flooded gravel pits, or artificial ponds with sparse vegetation and gradually sloping bottoms of mud or fine sediment, but even coves in large lakes are sometimes used. In hot, dry weather, toads often burrow into loose soil during the day, emerging only at night to forage. Cool or rainy weather allows them to remain active both day and night. When winter approaches, toads burrow deeper into soft soil or forest-floor litter, where they hibernate until the following spring.

**REPRODUCTION:** The beginning of the breeding season ranges from mid-April in southern Maine to mid-May in northern Aroostook County. The primary season is often brief, generally less than 15 days, but some calling activity can continue, intermittently, until early July (Sullivan pers. comm.). Breeding begins with males arriving at the breeding pools and commencing to sing. While singing, males sit erect at the water's edge, or in shallow water, keeping the inflated vocal sac above the surface. In deeper pools, they may select barely submerged rocks, logs, or debris as singing sites.

Males interrupt their singing and swim out to investigate any individuals entering their vicinity. Brief wrestling occurs on contact, but is quickly abandoned if the newcomer is not an eligible female. Males seized during such encounters frequently emit protesting chirps which, coupled with the absence of tactile clues, may serve to confirm their identity and induce prompt release. If no female is found after a succession of contacts, the male returns to the shore or shallow water and resumes calling.

Mated pairs often move to an undisturbed spot in shallow water a short distance away from the active callers to begin egg laying. The male fertilizes the eggs as the female slowly ejects them in two long, continuous, jelly-coated strings. The eggs are not attached to underwater objects, but may be threaded among submerged vegetation if present. They are more often stretched out in long, parallel, spiralling strings on the open bottom. Twin strings measured at New Sweden, Aroostook County, in May 1987 were 4 meters (13') in length and contained approximately 3200 eggs. The American toad's eggs can thus be distinguished easily from the globular egg masses of Ranid frogs. Egg development is partially temperature-dependent, but hatching occurs within 3–12 days (Wright and Wright 1949).

Toad tadpoles are black, making them readily distinguishable from those of other Maine anuran species. They sometimes congregate in schools, which may have the dual benefit of confusing predators and stirring bottom detritus into a rich food suspension in the water. Their chief predators include adult and larval diving beetles, dragonfly nymphs, and leeches.

Metamorphosis occurs approximately 50–60 days after the eggs hatch. The tiny new toads average 8–10 mm (.3–.4") in body length and can easily be mistaken for insects as they scurry for cover. In exceptionally hot, dry weather, many congregate in moist places beneath debris until conditions are favorable for dispersal. Female American toads reach maturity and



commence breeding 3 years after hatching. Males usually breed when 2 or 3 years old (Hamilton 1934).

**DIET:** Toads feed on a wide variety of adult and larval insects, arthropods, slugs, and earthworms. The type of prey is generally determined by availability and abundance, but toads can be selective. Experiments by Brower et al. (1960) showed that *Bufo terrestris* learned to reject bumblebees and their robberfly mimics by sight alone. Vision is of primary importance in prey location and recognition, but Martof (1962a) reported that *B. woodhousei* also detected the presence of insects by the sounds they produced.

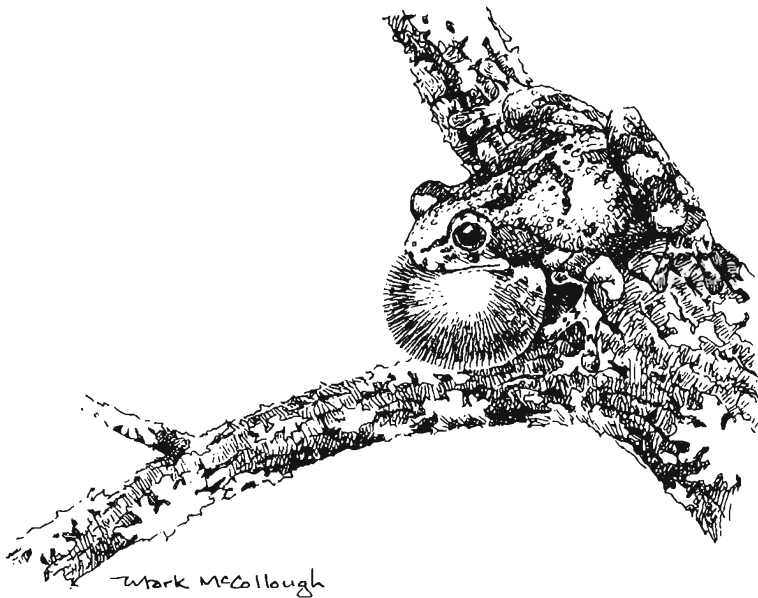
**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Principle toad predators include nocturnal mammals, particularly raccoons and skunks, and snakes. Antipredator defenses employed by toads include concealing or disruptive color patterns, escape, burrowing, ejection of urine, and noxious or toxic skin secretions. When concealment fails, escape affords little more protection. Toads typically flee in a series of short, unidirectional hops, followed by immobility, but these tactics are seldom effective in eluding an alert pursuer.

Lacking the agility of other anurans, toads commonly rely on noxious or toxic secretions rather than escape to avoid predation. Their skin toxins are mainly cardiotoxic steroids, which some mammalian predators (including domestic dogs and cats) painfully learn to avoid. Certain snakes appear to be immune, and some snake species are known to feed exclusively on *Bufo* (Duellman and Trueb 1986). The skin secretions pose no serious threat to humans, but can be irritating to mucous membranes. Fingers should be kept away from the eyes and mouth while handling toads, and the hands washed afterwards. Contrary to popular folklore, toads do not cause warts.

Their terrestrial habit frees adult toads from some of the afflictions common to aquatic species, but subjects them to other hazards. They are sometimes infested with chigger mites or ticks in regions where those arthropods are common (Duellman and Trueb 1986), but such parasitism has not been observed in Maine.

In view of their cosmopolitan occurrence, toads seem to be highly adaptable to environmental conditions, although one suggestion of the detrimental impact of human activities was made by Guttman (1975). He speculated that the low genetic diversity of toads from Priceville, New Brunswick might be due to natural selection for DDT resistance. Forests in that region had been heavily sprayed for spruce budworm, and toads reportedly had a fairly high DDT concentration in their tissues.

Carroll B. Knox, Caribou, Maine



## GRAY TREEFROG

*Hyla versicolor*

The gray treefrog has 42 things that other Maine frogs do not have: 18 special toepads plus 24 extra chromosomes, 48 chromosomes in all, twice as many as the “normal” number of 24. This tree-dwelling frog owes its grasping ability to expanded, adhesive toepads. The surface of each pad is composed of columnar cells interspersed with mucous pores (Duellman and Trueb 1986). The pores exude secretions that help create a surface tension that allows the frogs to cling to smooth vertical surfaces as well as rough tree bark. Adhesion of the skin of the belly, also by surface tension, supplements the adhesion of toepads.

The condition of having 4 sets of chromosomes (tetraploidy) in each body cell is a hidden feature of this species, but it is a very interesting characteristic nonetheless and will be discussed under “Taxonomic Status.”

**DESCRIPTION:** Gray treefrogs are not always gray; in fact, they are frequently green, but also may be light brown. Their Latin specific name, *versicolor*, refers to their ability to change color in response to changing temperature, humidity, and light. The dorsum of this species often has a ragged, star-shaped pattern. The venter is white in both sexes, but males have a dark throat, while females and young adults have just a few flecks of black on the throat. Under each eye is usually a black-bordered light

## Gray Treefrog

square. The yellow orange surface of the groin and hind legs is hidden when the frog is sitting, but is exposed when it leaps or is handled. Natural selection has "designed" this frog to be color-matched to its usual background, mostly lichen-covered tree trunks and branches.

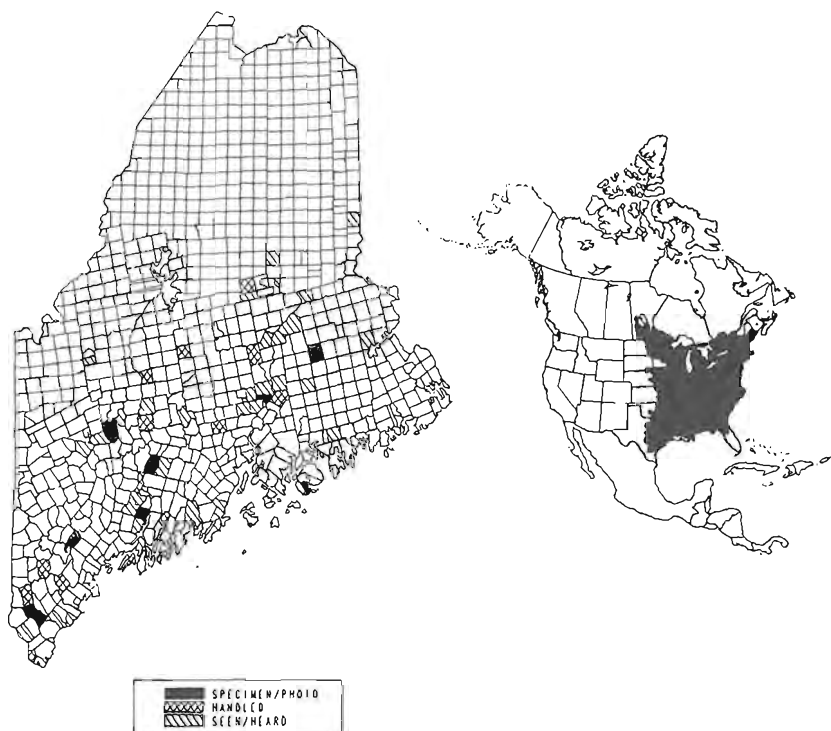
This species can be distinguished from the spring peeper by size and skin texture, as well as the color pattern. The gray treefrog is twice as large as the peeper, with females sometimes reaching 6.7 cm (2.3") and males ranging from 3.2 to 6 cm (1.2–2.0") (Wright and Wright 1949); an Orono population averaged 6 cm for females and 5.3 cm for males (Hinshaw and Sullivan pers. comm.). Its skin is so warty that many people refer to it as a treetoad, which it is not. The peeper, on the other hand, has a smooth skin.

The dark green or black tadpoles grow to 4.5–5 cm (1.7–1.9") and sport colorful wine, scarlet, or rose tailfins that extend along the back (Wright 1914). Newly emerged frogs are emerald green and average 1.6 cm (0.6").

**VOICE:** The mating call of a gray treefrog is a short, loud trill that lasts an average of less than half a second (Taigen and Wells 1985), but can be almost 3 seconds long (Fellers 1979a). The call may be repeated 10 or 11 times in a 30 second period, with 3–7 seconds between calls. Other Maine anurans with vocal trills are the American toad and the spring peeper. The toad's trill is distinguishable because it is much longer (6–30 seconds). The peeper's encounter call, given at the opening of a bout of calling, or when a neighbor is too close, may last 720–940 msec (Rosen and Lemon 1974) and is therefore more likely to be confused with the gray's trill. A trill coming from close to the ground and interspersed with single peeps at the same pitch is coming from a spring peeper, not a gray treefrog.

**TAXONOMIC STATUS:** The gray treefrog has twice the amount of DNA (48 chromosomes) as its presumed diploid ancestors (24 chromosomes). It is thought that during the Pleistocene glacial period, the ancestral species (*Hyla chrysoscelis*) took refuge in two areas, Florida and Mexico (Ralin 1977). While isolated from each other, these two populations changed genetically to a minor degree; then later, when the climate warmed, contact between these slightly different groups produced the tetraploid form now designated *Hyla versicolor*. The newer species has a slower call than its forerunner and does not interbreed with it because of the difference in chromosome number. The two species differ very little in appearance, physiology, or ecology. They overlap in range throughout a large portion of east-central North America, but probably not in Maine.

**DISTRIBUTION AND STATUS:** The gray treefrog appears to be largely limited to the southern and central portions of Maine, with few records in the east and one unconfirmed record from the north, in Hodgdon, southern Aroostook County. During the breeding season, they can appear to be very common in the pools where they congregate.



**HABITAT:** This species inhabits forested areas near shallow water. It is not often seen at the edge of water or on the ground, but rather it perches on tree and shrub branches. Its skin color blends in well with mossy or lichen-covered bark, making it hard to spot even when one hears it at close range. Breeding sites are variable and include both permanent water and temporary pools or swamps.

Gray treefrogs hibernate near the soil surface hidden under tree roots, leaf litter, logs, or rocks. They can tolerate temperatures of  $-6^{\circ}\text{C}$  for at least 5 days (Schmid 1982) and the freezing of up to 41.5% of their total body fluids outside of cells (Storey and Storey 1985). This is accomplished by the production and concentration of glycerol as an "anti-freeze" in response to subzero temperature. Sexually mature adults accumulate higher concentrations of glycerol than younger ones, and are therefore more resistant to severe cold spells.

**REPRODUCTION:** After two winter seasons, both sexes of gray treefrogs breed for the first time (Storey and Storey 1985). They are late breeders compared to most other Maine frogs, waiting until air temperature is over  $20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ) (Wright 1914). Males arrive first at the breeding pool and compete for calling sites. Females may arrive any time during the breeding season and are stimulated to ovulate by the chorus of males (Morris 1984).

At the height of the breeding season, some frogs vocalize at midday, but most calling begins in late afternoon and continues beyond midnight. A whole chorus of gray treefrogs is deafening, for the call of this species is one of the loudest measured for North American frogs (Taigen and Wells 1985).

Male breeding success is often correlated with perch site (Fellers 1979b). The "best" perch sites are horizontal and have relatively little vegetation immediately around them, features that probably enhance sound propagation of the breeding call. Male mating success does not correlate with a frog's size, the number of nights he calls, or with seasonal timing (early vs. late) (Fellers 1979a). It is not known what enables a frog to claim a "good" perch, but research indicates that other males selectively sit on perches where females have already mated. Thus, when a calling male leaves his prime calling site to fertilize eggs, his position will be claimed by a nearby male. Resident males defend their perches against other males, using encounter calls which differ from mating calls primarily in duration (Fellers 1979a). Encounters, initiated by the intruder, usually end after a vocal battle. Contestants sometimes actually fight by butting, kicking, shoving, or jumping on each other. Invariably the resident wins and the loser moves to another perch or sits silently near the water. He begins to vocalize when the resident male ceases calling and achieves amplexus.

During an evening, frogs in a chorus gradually increase their calling rate, going from 500–600 calls per hour to nearly 1400 calls per hour (Taigen and Wells 1985). This vocal advertisement is considered to be one of the most energy demanding activities ever measured in an ectothermic ("cold-blooded") vertebrate. Although a male only produces sound about 15% of the time, he invests so much energy in his loud, resonant trilling that he loses considerable weight after only a few nights of calling. Isolated males call more frequently than those in choruses, but their calls are shorter. The longest calls are produced when receptive females are approaching (Fellers 1979a).

Females approach loud-calling males very slowly, pausing between calls (Fellers 1979a). They appear to prefer males with longer, more rapidly repeated calls, perhaps an indication of his fitness (Klump and Gerhardt 1987). As a female approaches to within 15–25 cm, the male typically gives a call two to four times longer than before. The female nudges his side, stimulating him to turn and clasp her. After a long period of amplexus (4–5 hrs), they leave the perch and enter the water to lay eggs. By this time the chorus is tapering off and thus a male is unable to mate again that night. He may call from a different perch on other nights. A silent male will not interfere with an approaching female.

The female expels her eggs in packets of 10–40, loosely attached to vegetation at the surface (Gerhardt 1982). The total number of eggs laid by one female may be close to 2000 (DeGraaf and Rudis 1983). The outer capsule of each egg averages 5.2 mm, the vitelline envelope 1.7 mm (Wright 1914). The eggs hatch in 4 or 5 days at a temperature of 22°C and tadpoles mature in approximately two months.

**DIET:** Treefrog tadpoles, like other anuran larvae, have structures in the oral cavity that trap suspended particles of food from water (Duellman and Trueb 1986). The gill filters of the pharynx and the mucous surfaces of their foodtraps can catch very small particles of phytoplankton and periphyton (attached algae). Large particles of detritus bypass the pharynx and go to the esophagus directly.

Adult gray treefrogs forage mostly in trees, with an occasional trip to the ground. They are sometimes attracted to electric lights on the outside of buildings if insects are gathering there (Cook 1984). Prey animals include insects, mites, snails, and spiders.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** The arboreal lifestyle of adult gray treefrogs makes them less vulnerable than other frogs to earthbound predators. However, they are in full view to those predators that share the trees and bushes during daylight hours. Their cryptic coloration is therefore important to their survival. The flashy color on their flanks and thighs, common among treefrogs, becomes visible only during the moments when they leap. It is possible that the sudden burst of color startles would-be predators and allows the frogs to escape.

The larvae are much more vulnerable as prey. Many of the pools used for breeding by the gray treefrog lack large, efficient predators such as fish. There are, however, large populations of invertebrate predators, including dragonfly and beetle larvae, leeches, and crayfish (Hinshaw and Sullivan 1990). Tadpoles fall prey to a number of vertebrates such as predaceous salamanders, frogs, snakes, turtles, raccoons, and large birds. During the transforming state, when the young are neither good swimmers nor good hoppers, they are especially susceptible to predation by garter snakes (Arnold and Wassersug 1978).

In addition, the aquatic period allows parasites to gain entry. For example, 5% of the gray treefrogs in southern Ontario were found to be infected with a nematode that inhabited their small intestines (Baker 1977). The adult frog is also host to the urinary bladder generation of a fluke, which enters via the cloaca (Olsen 1962). Tadpoles host the fluke's branchial generation on their gills.

People rarely see these inconspicuous frogs, and thus impinge on their lives primarily through habitat destruction, as humans manipulate the environment for their own uses, often draining or diverting the water used by frogs for breeding sites.

Shirley L. Davis, University College, University of Maine, Orono



## SPRING PEEPER

*Pseudacris crucifer*

The smallest frog in Maine may be hard to see but it is not hard to hear. Its shrill, pure, high-pitched breeding call is heard all over the state in early spring. Hence, the name "spring peeper" is quite appropriate. The "peep," however, is not recognized by everyone as coming from a tiny frog. Some people suspect an insect or bird makes the sound, especially because it is so difficult to see the noise-maker.

In peak season, a chorus of peepers can be heard half a mile away. They begin calling in the afternoon and continue through much of the night. All this vocal activity is primarily designed to advertise to females: "I'm ready, willing, and able." Once mating season ends, the adult peepers disperse, fading into the background until another spring. Thus, during most of the year, one would never guess that this is one of the most common vertebrates in the state, perhaps second only to the redback salamander.

**DESCRIPTION:** Maine's smallest frog is one of two tree frogs in the state; the larger one is called the gray tree frog. Adult male peepers are typically 2–3 cm (.8–1.2"); females are a bit larger at 2.7–3.7 cm (1–1.4") due to a growth spurt at the end of the second year (Oplinger 1967). Young, newly transformed juveniles are 1.35–1.45 cm (0.52–0.56").

The skin of peepers is generally smooth, in contrast to the rough, warty

skin of the gray tree frog. There is great variation in skin color, but usually the back and sides are some shade of brown or gray. No doubt the most distinguishing feature is the dark imperfect cross or X pattern on the back. This accounts for the species name *crucifer* which means "one who bears a cross." The venter is plain yellowish or grayish white. The throat of the male is basically yellow, but during the breeding season it turns darker and is flecked with yellow. There is a dark stripe running from the snout to the tympanum and a dark v-shaped bar across the head between the eyes.

The skin color lightens at night; peepers can rapidly darken and lighten to match their background more closely (Kats and VanDragt 1986). The frogs appear to have a preference for settling on dark sites, with their skin changing from light tan to deep brownish black in 15 to 45 minutes.

Tadpoles have an orange dorsum with dark spots and a greenish tone, an iridescent creamy venter, and an orange tail with black splotches on the outer edge and a crest that extends along the back. They are about 3 cm long and their tail is 1.4–2.1 times their body length.

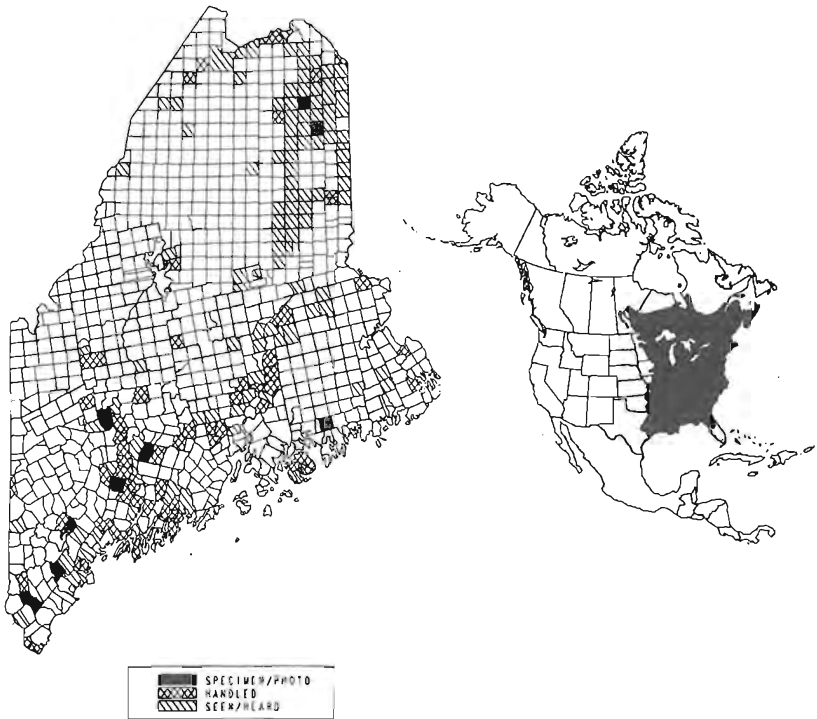
**VOICE:** The advertisement call is a very simple signal, a peep, with an average peak pitch of 2895 Hz (Wilczynski et al. 1984). In a Maine population, the dominant pitch was higher on warmer nights, and, independent of this effect, large males had lower pitches than small males (Sullivan and Hinshaw 1990). One male may call 15–25 times per minute (Wright 1914). Each "peep" ends with an upward slur. Occasionally, a longer call, a short trill, is emitted when another male is close by (Rosen and Lemon 1974).

**TAXONOMIC STATUS:** Until recently the spring peeper was considered a member of the *Hyla* genus of tree frogs, but gel electrophoresis data gathered by Hedges (1986) indicate that spring peepers should be transferred to the genus *Pseudacris*, which includes several southern species called cricket frogs. Species of *Pseudacris* are more terrestrial, breed during cold weather, possess smaller digital pads, and have spherical dark testes. Holarctic species of *Hyla* are arboreal species that breed during warm weather, have larger digital pads, and elongate white or yellowish testes. Other work suggests that the spring peeper is a member of a monotypic genus with a large number of osteological, morphological, biochemical, and behavioral characteristics of both *Hyla* and *Pseudacris* (Hardy and Borroughs 1986). The spring peeper, thus, may be neither a *Hyla* nor a *Pseudacris*. Two subspecies of *P. crucifer* are recognized; in Maine, we have *P. crucifer crucifer*, the northern spring peeper.

**DISTRIBUTION AND STATUS:** Spring peepers are abundant throughout Maine and eastern North America.

**HABITAT:** Spring peepers are found in deciduous, coniferous, and mixed woodlands near ponds, marshes, and swamps. There may be a preference for brushy second-growth areas (Conant 1975). During the breeding season one





can find them in almost any pool, ditch, or pond—grassy or muddy, temporary or permanent—within their range (Wright 1914). They tend to form choral groups where trees or shrubs stand in or near water.

After breeding, some peepers establish home ranges between 1.2 and 5.4 meters (4–18') in diameter around bark debris, logs, stumps, or other vegetation (Delzell 1958). Home ranges may overlap, but individuals do not interact. By fall they move from their home ranges, as much as 300 meters (1000'), presumably seeking a winter hibernation site in subterranean places. Single individuals may call from trees, bushes, or fields through September and October, but by November activity ceases and hibernation begins. This species is known to tolerate freezing of body fluids for periods up to two weeks when the soil surface dips below 0°C (Storey and Storey 1986). A glucose buildup in the blood and tissue fluids apparently protects the frogs during such cold spells.

**REPRODUCTION:** Migration to breeding sites occurs primarily on April nights between midnight and 6 am (Pechman and Semlitsch 1985). An air temperature of 5°C is required for first appearance (Wright 1914). May is the peak of the breeding season in Maine, and chorus activity is greatest on warm (15–20°C) rainy nights when light intensity is low. Some males remain at the reproductive site for up to a month, while females enter the pond,

breed, and leave within a day or two (Delzell 1958). Males occupy calling sites on the ground or in shrubs or grasses around the water and reoccupy these sites over several successive nights (Wilczynski et al. 1984). According to one study, they space themselves apart so that they can just barely hear their neighbors' calls (Brenowitz et al. 1984), although another study found they were well within hearing range of their neighbors, 21–124 cm (Gerhardt et al. 1989). On cool, dry nights peepers call from the ground, but on warm, humid nights they choose more elevated perches. If the males are on or near the ground, a female can simultaneously sample the calls of about 4 males, but if they are slightly elevated (50 cm above ground) she can choose from 5 to 6 males (Brenowitz et al. 1984).

Interestingly, there is sexual dimorphism in the hearing of peepers. The ear of females is tuned to the calling frequency of the males, so that females hear the males at quite some distance. Males, however, can barely detect their own call (Wilczynski et al. 1984). Research suggests that the frequency or pitch of the call is almost certainly not used by females to select among potential mates (Doherty and Gerhardt 1984). However, there is evidence that females select loud, fast calls over quiet, slow calls (Forester and Czarnowsky 1982).

Some males, up to 14%, do not call, especially when chorus density is high (Forester and Lykens 1986). These sexual parasites or satellite males are smaller, keep a low posture, and are quite agile. They intercept females attracted to calling males, and thus are using a different strategy to attain reproductive success.

Both sexes begin reproducing at one year of age when about 2 cm (0.8") long (Delzell 1958; Collins 1975). Females seek males and touch them before amplexus occurs. When mounted, the female dives to the bottom, periodically surfacing for air. During egg laying she hugs a stem or stick, and may lay as many as 900 eggs, attached singly to submerged vegetation; smaller females produce fewer eggs. Each egg is approximately 1.1 mm (0.04") in diameter (Duellman and Trueb 1986). The eggs develop in about 6 days if the water is warm, and the larvae then spend the next 2–3 months as tadpoles. Mature larvae may reach a length of 3.3 cm (1.3"), 2/3 of which is tail. Surviving tadpoles transform at 1.25 cm (0.5") (Delzell 1958) and, as newly transformed frogs, are terrestrial for the remainder of the season.

**DIET:** The larval peeper feeds primarily on microscopic organisms such as diatoms and other types of algae that are attached to underwater surfaces. Young of the year feed primarily on spiders, ants, and beetles, but also take mites, ticks, springtails, caterpillars, and terrestrial gastropods (Oplinger 1967). Older adults feed very little in early spring, eating only their castoff skin, which is the sloughed-off outermost layer of epidermis. Both salamanders and anurans shed periodically, starting with a skin-split on the head and progressing posteriorly (Duellman and Trueb 1986). Most amphibians loosen and remove this thin layer with their legs and proceed to eat it.

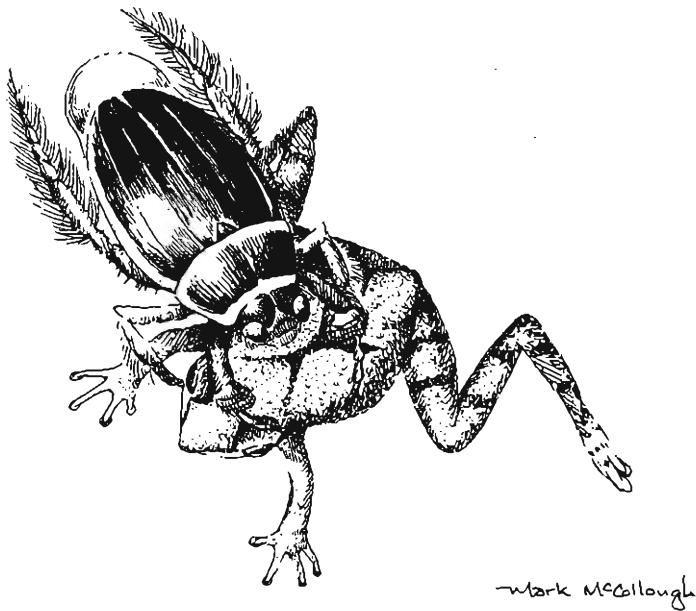
## Spring Peeper

In May, spiders are the most frequent prey. In autumn, spiders still account for 48% of the diet, with mites, sowbugs, leafhoppers, ants, harvestmen, nematode worms, and lepidopteran larvae making up the rest (Gilhen 1984).

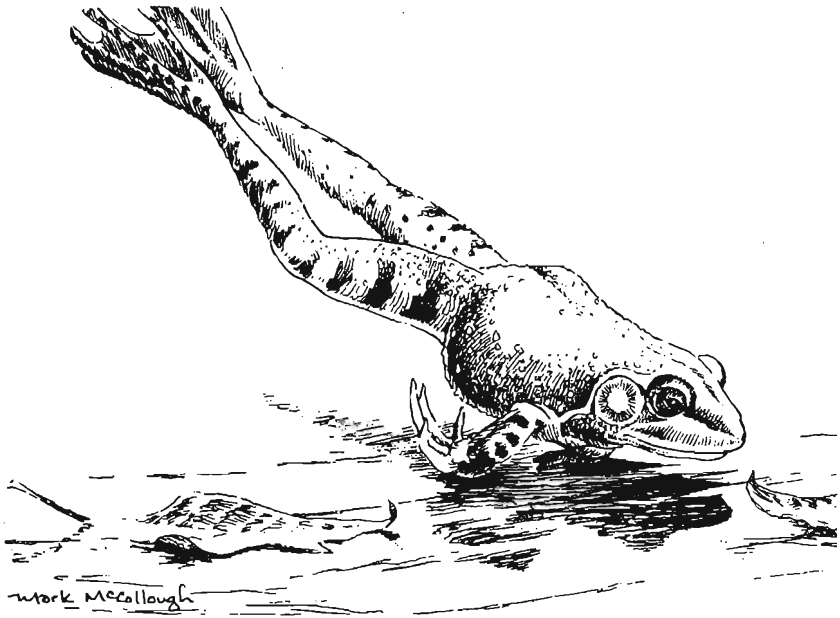
**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Night migration may be a strategy to avoid predators such as diurnal snakes and birds. Aquatic predators such as fish, other frogs, newts, and large carnivorous insects take many tadpoles. This predation can benefit surviving tadpoles by reducing competition (Morin 1983). A giant water bug has been seen devouring an adult pair of peepers in amplexus, and a *Dytiscid* diving beetle was observed consuming an adult male (Hinshaw and Sullivan 1990). Cold-weather breeding and preference for shallow, temporary water may reduce competition with other anuran species and help them avoid predatory invertebrates (Hedges 1986).

The current practice of draining and filling wetlands for human use is undoubtedly reducing populations of spring peepers. This small, ubiquitous frog would be sorely missed if its impressive chorus no longer signaled the approach of spring, but given their abundance, this scenario is hard to imagine.

Shirley L. Davis, University College, University of Maine, Orono



*Dytiscid diving beetle capturing a spring peeper.*



## BULLFROG

*Rana catesbeiana*

The bullfrog boasts more descriptive superlatives than perhaps any other Maine frog. It is the largest anuran in the United States and has the longest developmental period; it is the most wholly aquatic of Maine's frogs; it is the last to emerge from hibernation to breed; and it is the most aggressively carnivorous of our frogs. Its distinctive booming voice has been celebrated in song and story more than that of any other frog. And it is the only amphibian to have acquired "game species" status in North America.

**DESCRIPTION:** The bullfrog is the largest of all North American anurans and the largest frog encountered in Maine. Adults may reach a length of 20 cm (7-8") from tip of nose to vent. The dorsum of adults is generally uniform in color, ranging from light green or olive to a very dark green or brown. The color of an individual is evidently variable since very dark individuals taken from deep, dark waters will lighten in color when removed to brighter, sunlit situations. The venter is usually a pearly or creamy white. Faint, darker spotting or mottling may be present on either the dorsum or venter. In males, the throat is pale to bright yellow; in females, the throat is the same color as the rest of the venter. Also, the male's tympanum is obviously larger than the eye diameter; in females, the tympanum is equal to eye diameter.

The dorso-lateral fold is nearly absent except for a short fold beginning

## *Bullfrog*

just behind the eye and curving down and immediately behind the tympanum. The absence of a dorso-lateral fold serves to separate bullfrogs from green frogs, a similar species that overlaps the bullfrog in size. Mink frogs sometimes lack a dorso-lateral fold and could be confused with a small bullfrog. Other distinctive features, notably the musky odor and more boreal habits of the mink frog, can be used to separate the two species.

Bullfrog tadpoles are light to dark mottled green or brown dorsally, with a bronze iridescence on the venter and sometimes extending to the sides. Their tails have black spots, some round and some dumb-bell shape. First season larvae measure 3–3.5 cm (1.2–1.5"); second season larvae (one year after egg laying) measure 7.5–9 cm (3.0–3.5"); and third season larvae (two years after egg laying) measure 10–14.5 cm (4.0–5.7"). Third season larvae show well-developed hind legs prior to actual transformation.

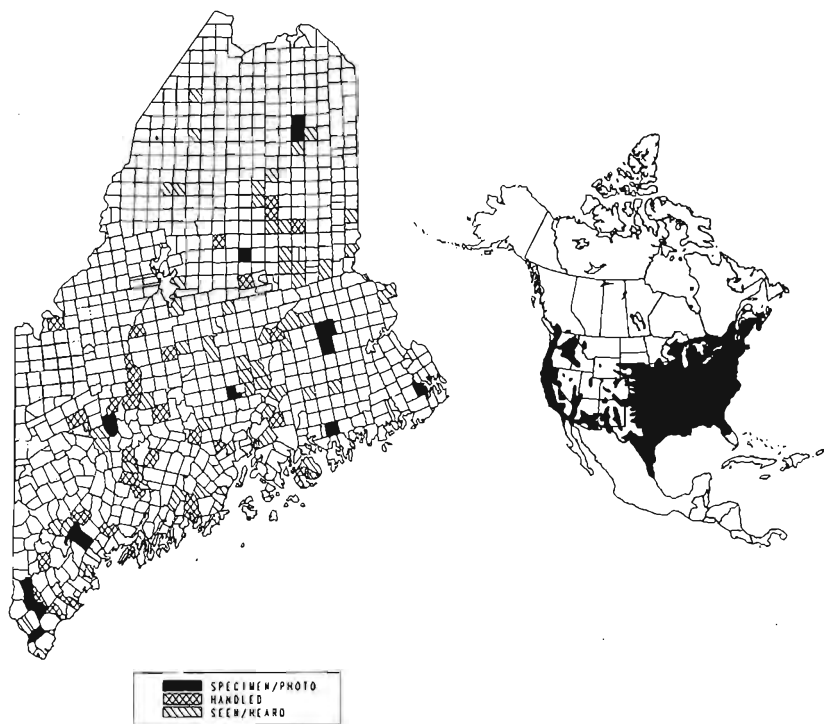
**VOICE:** The bullfrog's celebrated call is a deep-throated "jug-o-rum" that carries far across the water and characterizes a summer evening almost as well as the spring peeper's peeping typifies a spring night.

**DISTRIBUTION AND STATUS:** The bullfrog probably ranges throughout Maine, except perhaps from northern Oxford County through the U.S.-Canada border region in extreme northwestern Maine. It is more abundant in southern and central Maine, probably because the climate is warmer and fewer of the ponds and rivers are associated with low-nutrient peatlands.

**HABITAT:** The bullfrog is restricted to aquatic habitats including shallow bays and coves of large lakes, slow-moving rivers, streams, and backwaters, and natural and artificial ponds. The primary habitat requirement is a permanent water body with abundant emergent and shoreline vegetation.

Within their habitat, both adult and larval bullfrogs remain in the cover of vegetation, either floating or perched among water plants, or sitting at the water's edge. Adults will also sit on floating logs or debris, where they either bask in the sun or wait to ambush prey. First year larvae spend much of their time in shallows, hiding under bottom vegetation or debris. Second year larvae are more likely to be found at the water's surface, hiding in thick vegetation. When disturbed, these second year larvae will emit a loud chirp as they splash their way to better cover in deeper water. At times, when many larvae are concentrated in one area, the water virtually boils with fleeing tadpoles.

**REPRODUCTION:** Bullfrogs are the last frogs to breed in Maine, long after spring has become full summer. By the time bullfrogs emerge from hibernation and begin their all-night booming choruses, other frogs have completed courtship and egg laying. Overwintering bullfrog tadpoles emerge first, followed by subadults, then adults. The earliest dates for emergence by adults can be the first of May, but more typically, emergence occurs in mid-to late May.



Bullfrogs remain silent up to a month after emergence before they begin courtship. Their singing, which signals the onset of courtship, is perhaps a misnomer since researchers typically refer to a bullfrog breeding area as a “booming ground.” Males typically call at night, and amplexus and egg laying occur then, but some bullfrogs continue to call during daylight hours.

Bullfrogs in Maine breed when air temperatures are warm and water temperatures reach 20–22°C (68–72°F), usually mid- to late June and July. Males will defend territories up to 6 m (18') in diameter (Emlen 1968), and large males usually defend high-quality sites where egg survival is high (Howard 1978). Some researchers, however, note that territorial defense is not absolute, and at times many males will be found concentrated in one small area (Wright 1949).

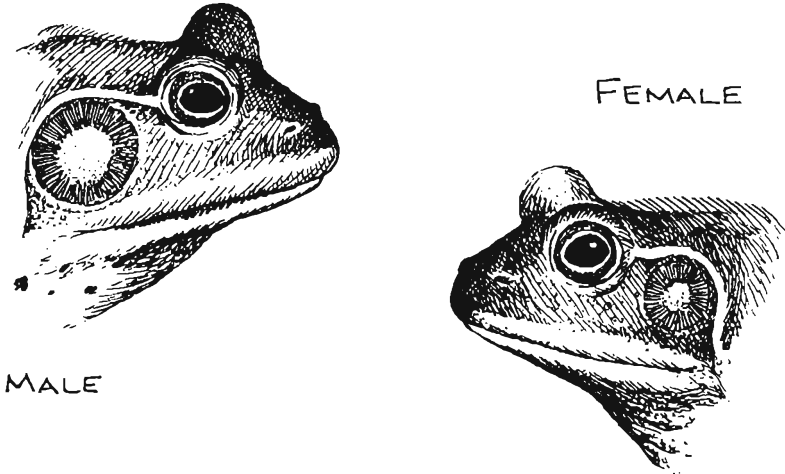
Eggs are laid singly within a large, jelly envelope, usually in the territory of the male that copulated with the female (Howard 1978). The egg mass floats on the surface of the water, and unlike other frogs', occurs as a thin film up to .6 m (2') in diameter. From 12,000 to 20,000 black and creamy white eggs, each 1.23–1.7 mm (.05–.07") in diameter, are laid in each mass. Eggs hatch in four to twenty days, depending on water temperature. The tadpole phase usually lasts two winters. The transformation to adult form requires a 10–20 day period and occurs from late June to early August. Subadult bullfrogs reach sexual maturity in four to five years.

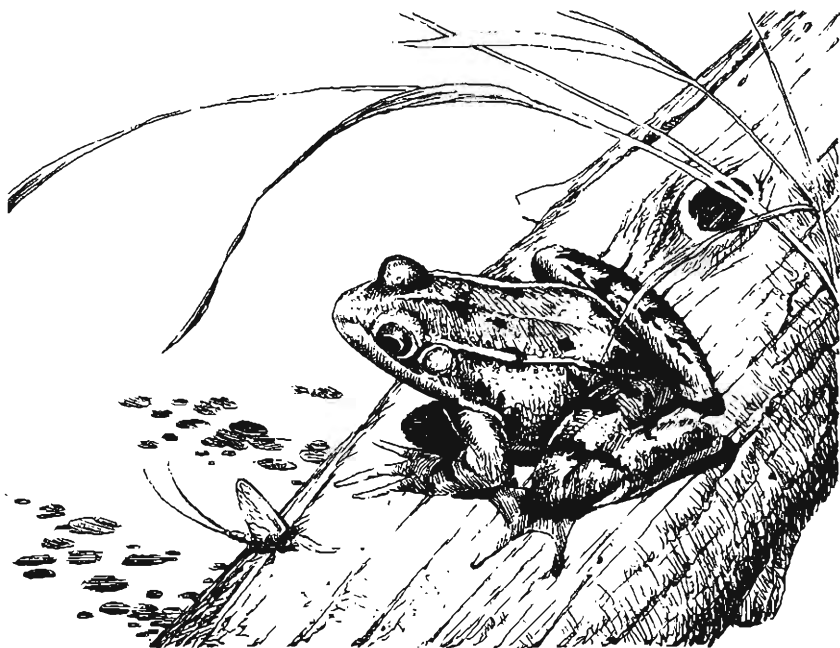
## *Bullfrog*

**DIET:** Adult bullfrogs are aggressive predators. Their diet includes snakes, fish, and small turtles, and even mice and young waterfowl. They are cannibalistic, eating their own young, and they also eat adults and tadpoles of other frog species. They eat virtually any invertebrate life they can catch, including crayfish, diving beetles, dragonfly nymphs, beetles, spiders, and numerous larvae and adults of other aquatic insects. Bullfrog tadpoles are primarily vegetarian, snipping the ends of young aquatic plants with their well-developed teeth, or grazing algae-covered detritus. Tadpoles also will scavenge dead animal matter, especially fish.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Although bullfrogs are large and aggressive, they are preyed upon by many other animals, especially wading birds such as herons, raccoons, mink, snakes, and other larger bullfrogs. Tadpoles fall victim to predacious diving beetles and dragonfly nymphs. Bullfrogs are also actively pursued by humans who have acquired a taste for frog legs. Early accounts of this species even refer to frog legs bringing one cent per pair for legs up to five years old, but caution that "advertisements of 'frog farms', claiming a market for breeders at \$6.66 per pair, are questionable" (Palmer 1949). Many states regulate taking of bullfrogs, thereby assigning them to "game species" status. No such regulations exist for Maine. Bullfrogs require abundant emergent and shoreline vegetation and increased shoreline development for homes and recreation has reduced habitat for bullfrogs in some areas.

John Albright, Maine Natural Heritage Program, Augusta, Maine





## GREEN FROG

*Rana clamitans*

It's a rare pond in Maine that does not ring with the banjo-string call of a male green frog during the summer months. The green frog is one of the more common frogs in Maine; look for it on the banks of ponds and streams or in the midst of a swamp. It rarely ventures more than a few meters from water. The name *Rana clamitans* means "frog that cries loudly," referring to the loud squeak made by individuals as they leap away from danger.

**DESCRIPTION:** The green frog is generally greenish or greenish brown above, with numerous dark brown or grayish spots or blotches. Dusky bars run across the legs. The venter is white, although dark spots or mottling can be present under the legs and head, and the throat of adult males is bright yellow. Dorso-lateral folds are prominent, extending almost the entire length of the back and branching almost at right angles behind the tympanum. Often the ridges are interrupted just before they terminate. In adult males, the tympanum is larger than the eye (Stewart 1983).

Green frogs could easily be confused with both the larger bullfrog and more aquatic mink frog, but bullfrogs never have prominent dorso-lateral folds and adult mink frogs smell musky when handled. Furthermore, the webbing on the toes of the hind feet of the green frog rarely passes beyond the second joint of the fourth toe and never reaches the tip of the fifth toe.



In the mink frog, this webbing extends to the last joint of the fourth toe and to the tip of the fifth toe.

Adult green frogs range from 6–10.5 cm (2.4–4.2") long, with females being somewhat larger than males. Adults usually reach sexual maturity the first summer season after metamorphosis, when males are between 6–6.5 cm (2.4–2.6") long and females are between 6.5–7.5 cm (2.6–3.0") long. Some individuals may not breed until the second year after transformation.

Tadpoles are olive green with numerous dark spots on the dorsum and an iridescent cream color on the venter. The throat and sides are mottled with dark green, and the tail is green mottled with brown. Tadpoles grow to 6.4 cm (2.6") long and have an elongate tail with an acute tip. The larval stage lasts a little over one year, then tadpoles metamorphose into frogs that measure between 2.8–3.8 cm (1.1–1.5") long.

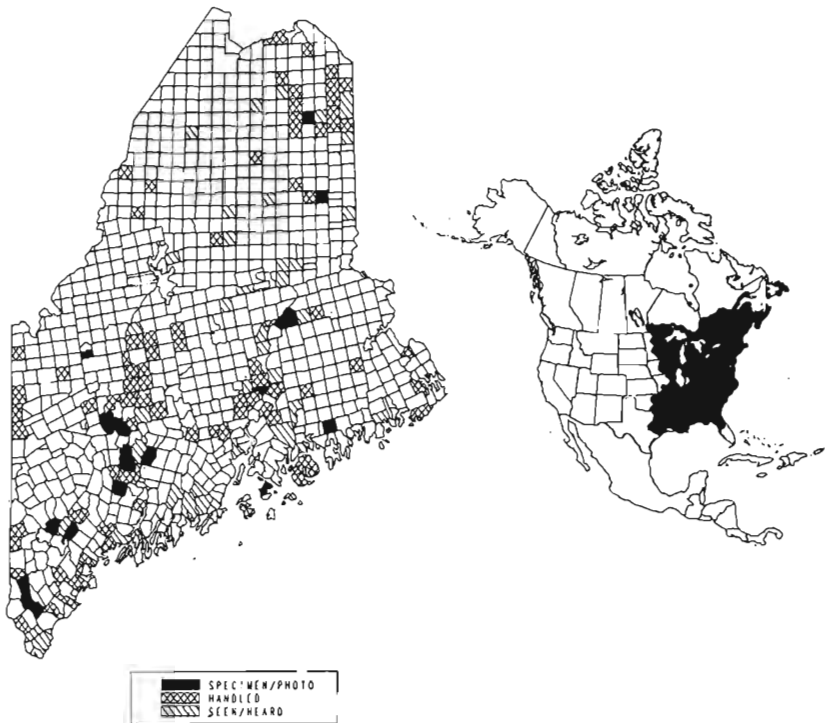
**VOICE:** During the breeding season, males emit a single explosive note that sounds much like plucking a loose banjo string. Occasionally, males will repeat the note 3 to 4 times, each note getting progressively softer. Using sonagrams, Wells (1978) was able to distinguish different calls used in different contexts.

**TAXONOMIC STATUS:** Maine's green frog belongs to the subspecies *Rana clamitans melanota*.

**DISTRIBUTION AND STATUS:** Green frogs are common throughout Maine. They were the second most abundant species, after wood frogs, in a study (based on captures in pitfall traps) of the herpetofauna of eight different types of vegetation found in Maine peatlands (Stockwell and Hunter 1989).

**HABITAT:** The green frog seldom ventures far from water and can typically be found on the shores and banks of ponds, lakes, and streams. It also inhabits springs, vernal pools, and moist woodlands. Green frogs need water to avoid desiccation; they also use it as a refuge from predators. Smaller frogs hide and feed in shallow water along the margins of ponds and streams and are active primarily during the day, whereas larger frogs hide in deeper water during the day and feed on the banks of ponds and streams during the evening (Martof 1953a). Rarely, green frogs will search for food in the deep aquatic zone of a pond or stream (Stewart and Sandison 1972). Immediately before, during, and after heavy rainfall, green frogs may wander up to 20 m (66') from water (Martof 1953a). Both male and female green frogs defend territories in which they feed, rest, and hibernate. Green frogs hibernate either underwater or underground from October to March. Tadpoles overwinter under silt and dead vegetation.

**REPRODUCTION:** Green frogs breed in ponds, lakes, or pools in streams from May to August. Males usually call from several sites during one



breeding season (Martof 1956; Wells 1977a). They are most active at night, but sometimes call during the day, and usually call from dense cover of overhanging bushes, tree stumps, cattails and bulrushes (Wells 1977a). Most males remain solitary throughout the breeding season, but in some populations males gather in large groups, sometimes called congresses, later in the season (Martof 1956). Males will remain on the breeding grounds for up to two months, but females normally only visit the breeding sites for about a week, during which time they mate and spawn (Martof 1953b). Larger males are dominant over smaller males, defend better breeding sites, and breed with more females (Wells 1977a). After breeding, green frogs return to their home range.

Green frogs deposit their eggs in shallow water of ponds and lakes. Many females lay two clutches in one season. Egg masses range from 15–30 cm (5.9–11.8") in diameter and contain 1500–5000 eggs. Clusters are laid in floating masses of jelly and are attached to emergent and floating vegetation (Martof 1956). Eggs are black and white and hatch after 3–5 days.

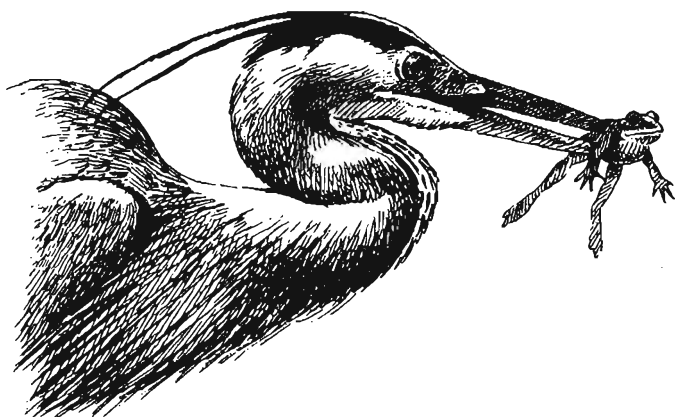
**DIET:** Tadpoles feed primarily on algae, especially diatoms, but also eat various entomostracans (small crustaceans) and fungi, and ingest sand, decomposed plant material, and other debris (Jenssen 1967). Tadpoles eat continuously, even in winter, but fast briefly from the time forelimbs break

through the body walls until the tails are almost absorbed (Jenssen 1967). Adults feed primarily on terrestrial beetles and flies, grasshoppers, and butterfly and moth larva, but also eat spiders, water bugs, molluscs, crustaceans (mostly crayfish), millipedes, adult butterflies and moths, their own cast skin, and small frogs (Hamilton 1948; Stewart and Sandison 1972). Their diet chiefly reflects habitat use and thus can vary markedly from one site to another. Green frogs hunt by selecting a stand and waiting for prey to come within easy striking distance.

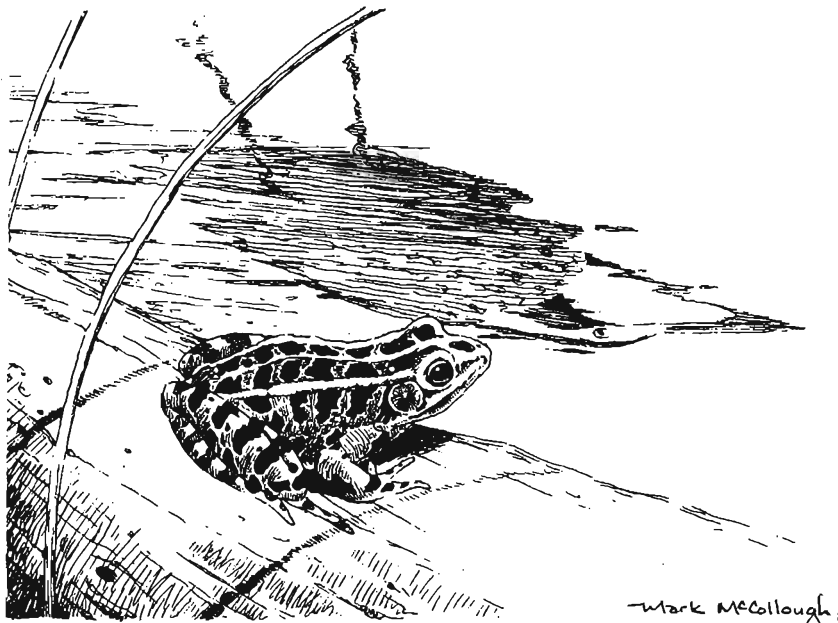
**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** At all stages of development, green frogs have many predators (Martof 1956). Eggs are eaten by snapping and painted turtles. Tadpoles are eaten by diving beetle larvae, water beetle larvae, whirligig beetle larvae, giant water bug adults and nymphs, water scorpions, backswimmers, and dragonfly naiads. Black ducks, mallards, herons, bitterns, rails, northern harriers, and crows will eat both tadpoles and adults. Small adults are eaten by larger members of their own species and by bullfrogs; larger adults are eaten by snakes, mink, and raccoons.

Despite their many predators, green frogs remain one of Maine's most common and widely distributed frogs. Next time you are out walking beside a pond or stream or stomping through a wetland, listen for that banjo playing and watch for the "frog that cries loudly" as it jumps into the water seeking protection from your disturbance.

Sarah S. Stockwell, Maine Audubon Society, Falmouth, Maine



Mark McCollough



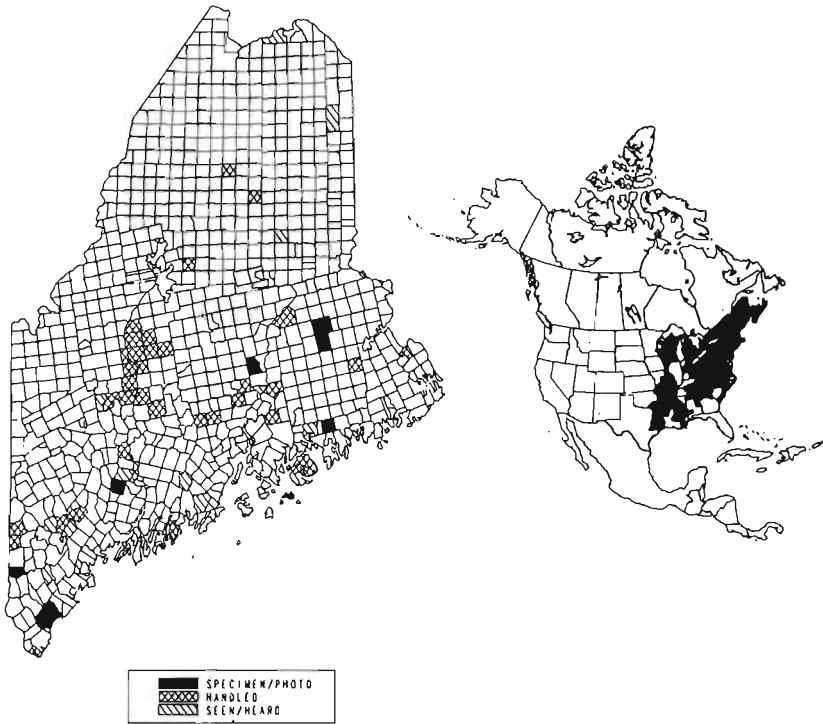
## PICKEREL FROG

*Rana palustris*

It's a safe bet that most experienced Maine outdoors people have encountered pickerel frogs in the course of their sporting endeavors, but it would probably be almost as safe a wager that most of these folks do not recognize them. This is not because *Rana palustris* is scarce or hard to observe; the species is, in fact, widespread, common, and highly visible in appropriate habitat. Pickerel frogs are not well known because they so closely resemble their near relative the leopard frog. Many observers simply lump the two species together as "grass" and "spotted" frogs. The pickerel frog is very much its own species, however, with unique characteristics and attributes.

**DESCRIPTION:** Pickerel frogs are of medium size, ranging from 4.4–7.6 cm (1.8–3"). They are bronze brown in color, with two parallel rows of squarish darker spots down the back, and are colored a bright yellow orange on the under surfaces of the hind legs. The similarly spotted leopard frog is usually green, but also has a brown phase. The leopard frog's spots, however, are more circular, are surrounded by borders of a lighter color, and are less apt to be arranged in two neat rows. Also, the leopard frog lacks the bright color under its legs.

## Pickerel Frog



Although male pickerel frogs are often smaller and lighter colored than females, the easiest way to distinguish sexes is to note the size of the first finger ("thumb"); in males, this digit is much swollen during, and for awhile after, the breeding season. The males also possess vocal sacs, which appear as small lateral swellings between tympanum and foreleg.

Tadpoles of this species have dark green backs, yellowish sides and creamy white, iridescent bellies, with tiny yellow and black spots over the dorsal surface. The tail is dark, sometimes almost black, usually with the same spotting as that found on the back. Full-grown larvae can measure 2.5 cm (1") in body length (snout to vent), with a tail almost twice as long.

**VOICE:** The pickerel frog's low-pitched grating croak is somewhat reminiscent of a rusty door being opened slowly. It is similar to the song of the leopard frog, but shorter and not so loud.

**DISTRIBUTION AND STATUS:** The pickerel frog is found throughout Maine in sizable numbers.

**HABITAT:** The pickerel frog is ubiquitous throughout Maine, inhabiting the shores of lakes, ponds, and streams. Although it is less abundant in the cattail marshes and sedge meadows so favored by leopard frogs, the pickerel frog is more apt to be found around spring runs, hilly ravines, and even

sphagnum bogs. After breeding it often moves to fields, meadows, and damp woods, where it can be collected with leopard frogs and other members of its genus. Pickerel frogs usually hibernate in the mud of pond bottoms, but they are apt to enter dormancy later than some other frogs and have been known to move about on the bottom of springs during the winter.

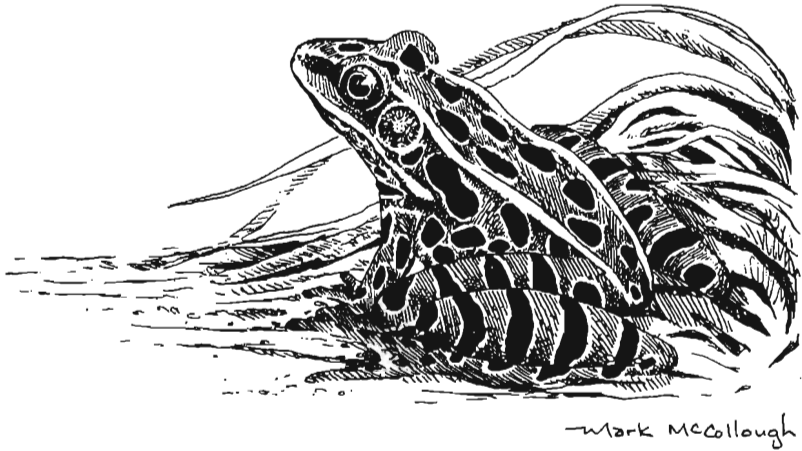
**REPRODUCTION:** In Maine pickerel frogs usually emerge from hibernation in late April or early May, depending upon latitude and weather. The male's call—sometimes described as a snoring grunt—is audible at no great distance. It is often given while the frog is submerged, sometimes during the mating embrace. Pickerel frogs are gregarious during the mating season and seem possessed of much amorous ardor. Amplexus is the usual *Rana* pectoral embrace, and in this species it sometimes continues for several days after the eggs have been laid (Wright 1914). Mated females are nervous; thus actual oviposition is difficult to observe. Laying generally commences when air and water temperatures are above 10°C (50°F) and peaks with air temperatures around 15–20°C (mid-60s°F).

The globular egg masses are firm, measure 5–10 cm (2–4") in diameter, and are usually attached to submerged sticks. Individual eggs are brown and yellow in color, and range from 3.6 to 5 mm (.14–.20") across including the gelatinous envelope. Most masses contain 2,000–3,000 eggs. Hatching occurs from 11 to 21 days after oviposition (Wright 1914). Pickerel frogs remain in the tadpole stage for nearly 3 months, with most of the newly transformed frogs measuring about 2.5 cm (1") in body length.

**DIET:** Adult *R. palustris* feed on a wide variety of terrestrial invertebrates, including insects (notably Hemipterans, beetles, caterpillars, and ants), spiders, harvestmen, sowbugs, and mites (Gilhen 1984). Aquatic food items include snails, small crayfish, amphipods, and isopods (Dickerson 1931).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Bright orange coloration, such as occurs on the under surfaces of pickerel frog hind legs, is often a warning of toxicity in the world of frogs and their predators. Several authors (Wright 1914; Conant 1957; Logier 1952) have noted the toxicity or distastefulness of pickerel frogs to potential enemies, and there are several accounts of other frog species placed in water-filled collection jars with *R. palustris* being killed by the latter's skin secretions. Pickerel frogs can often be found in the cages of Maine bait dealers alongside green, leopard, and bullfrogs. Several early writers ascribe this species' common name to its favorable reputation as bait for pickerel, and we are aware of one Maine record of *R. palustris* from a pickerel stomach in January (B. Burgason pers. comm.). Although little data exist, pickerel frogs likely fall prey to a broad spectrum of vertebrate predators.

Donald F. Mairs, Belgrade, Maine



## NORTHERN LEOPARD FROG

*Rana pipiens*

The northern leopard frog is well known in teaching and research labs and thus is often called the “laboratory frog.” Outside the laboratory, the northern leopard frog is commonly called the “meadow frog” because of its semi-terrestrial lifestyle in damp grassy areas. The leopard frog may take the prize for the most common names, which include shad frog, herringhopper, common frog, spotted frog, grass frog, and water frog. When you are out “frogging” in wet areas or “night driving” on rain-slick back roads, the northern leopard frog can easily be mistaken at first glance for the pickerel frog, *Rana palustris*, which closely resembles the leopard in size and body markings.

**DESCRIPTION:** The leopard frog is a slender, medium-sized frog; females range from 5.4–9.5 cm (2.2–3.8”) snout-vent length, and males range from 5.2–8.2 cm (2–3.2”). Only one other species of frog in Maine, the pickerel frog, has distinct spots. In the leopard frog, two to three unevenly spaced rows of irregular oval-shaped dark spots pattern the dorsum. The pickerel frog, in contrast, has two parallel rows of evenly spaced, squarish spots. The spots have light borders on a background of green and/or brown shades. Also look for two spots, one over each eye. When inactive, elongated spots on the legs form one to four bands (Gilhen 1984). The undersides of the frog are white

to grayish white and are unmottled. Occasionally, northern leopard frogs without spots on their backs are reported (Merrell 1965, 1970), but none have been reported in Maine.

Blue leopard frogs have been documented in Maine, as have blue bullfrogs and green frogs (Berns and Uhler 1966). The blue color occurs when the skin lacks the surface pigment that would normally absorb blue light (see Black 1967 for summary). Without the pigment, blue light is reflected, and we see a blue frog instead of a green frog.

During the breeding season, males can be distinguished from females by comparing the thumbs; in males these digits are enlarged or swollen to allow the male to securely clasp the female in amplexus. Two external vocal sacs are only visible when males are calling.

Tadpoles of the leopard frog have a combined body and tail length no greater than 8.4 cm (3.3"). The pollywog is dark brown with fine gold spots dorsally with some aggregating on the sides. A bronze iridescence overlays a cream-colored ventral surface. The snout area may have an orange appearance, and the eyes are bronze. The tail, being a lighter color than the body, is marked with scattered fine spots and pencilings (Wright 1914).

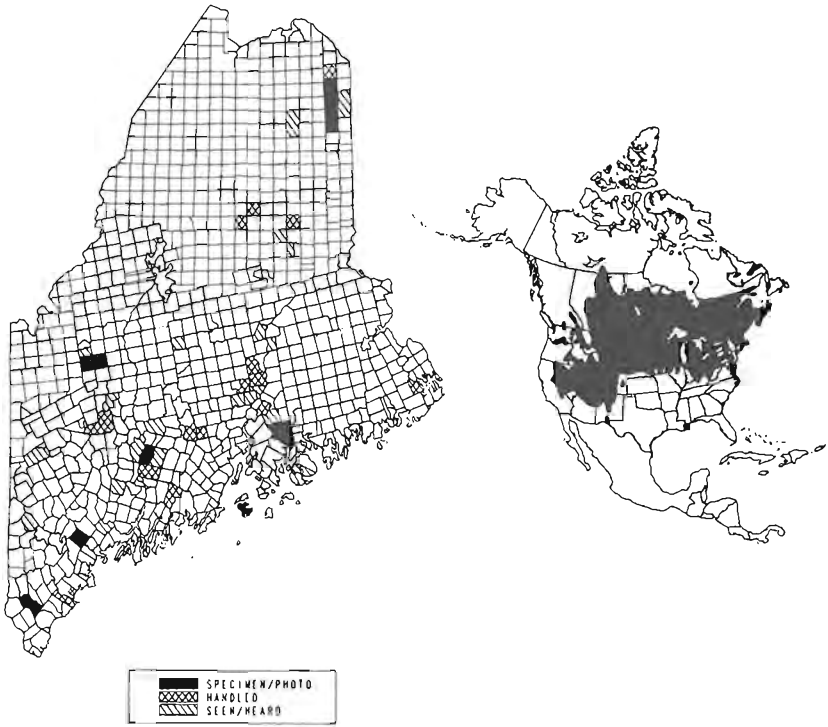
**VOICE:** Leopard frogs give three vocalizations, the advertisement call, the release call, and the warning cry. Associated with these vocalizations are various types of chuckles described as grunts, putts, clicks, burps, and quacks (Schmidt 1968). The advertisement call used to attract females is commonly described as a long drawn out guttural snore lasting up to three seconds. The call is imitated as "ir-a-a-a-----a-a-h" followed by several "rah-rah-rah's" if the male is pursuing a female (Noble and Aronson 1942). The advertisement call is given while the male is "spread-eagled" on the water surface, or sometimes underwater (Cook 1984). The release call is a short series of trills ("ir-a-a-ah--- ir-a-a-ah--- ir-a-a-ah---") used when males are clasped by other males or by females that are not gravid (Noble and Aronson 1942). The warning cry, an untrilled scream, is given with an open mouth when the frog is startled or captured by a predator.

**TAXONOMIC STATUS:** The northern leopard frog is a sibling species belonging to the leopard frog complex. The complex is made up of at least twenty species (Hillis et al. 1983) ranging from North America to Middle America. In several parts of the United States, zones of sympatry have caused confusion in correctly identifying the various forms of the leopard frog (Moore 1975; Brown 1973; Fowler 1942), which was once considered to be a single species (review in Brown 1973). The closest relative of the complex to Maine, the southern leopard frog, *Rana utricularia*, with a white spot on the tympanum and a more pointed snout, does not range farther north than southeastern New York and northern New Jersey.

Overharvesting of the northern leopard frog has forced biological supply houses to obtain leopard frogs from numerous geographic areas (Bagnara and Frost 1977), and several leopard frog species may be present



## Northern Leopard Frog



in a single shipment. Thus, researchers caution against the use of leopard frogs obtained from supply houses in experiments because of interspecific variability in traits (Bagnara and Frost 1977; Brown 1973). Conservationists caution against releasing laboratory frogs into the wild lest they threaten the genetic character of local populations.

**DISTRIBUTION AND STATUS:** The northern leopard frog's range covers the entire state of Maine. In most areas it is less common than the pickerel frog.

**HABITAT:** The leopard frog is semiterrestrial. During the summer months (late June to August) the adults spend their time in grassy areas or damp wooded areas well away from water, but return to the water to hibernate (September to October) and breed (May to late June). Brattstrom (1968) has found that the low and high lethal temperatures for *Rana pipiens* are  $-1.6^{\circ}$  and  $35^{\circ}\text{C}$ , respectively ( $29.1^{\circ}$  and  $95^{\circ}\text{F}$ ). The northern leopard frog cannot withstand prolonged freezing and must overwinter in permanent bodies of water or streams (Schmid 1982). In streams, they stay under rocks (Cunjak 1986); in ice-covered ponds they reside in excavated hibernation pits that average 10 cm (4 inches) in diameter (Emery et al. 1972). The adults come out of hibernation in late April before the juveniles (Dole 1967a). The frogs

migrate to their home breeding areas with a strong degree of accuracy possibly using any one, or combination, of solar, celestial, and lunar cues (Dole 1968). Home areas are shallow bodies of water having emergent vegetation seen in lake inlets, slow streams, ponds, or overflows. Other than reproductive requirements, the frogs are confined to the water by a greater food abundance, an intolerance to extreme air temperature fluctuations away from the water, and a lack of protective covering in the summer habitats (Dole 1967a). To avoid overheating during the day the frogs regulate their body temperature by evaporative cooling while basking on lily pads or in open areas, but are found in the water during cooler days and at night where the water temperature is warmer than the air temperature (Brattstrom 1963). By July the frogs are well away from the water and have moved into the meadows. During this time they absorb water through the groin area by sitting on dew covered plants or moist soil (Dole 1967b). Often inactive during the day, they will sit in an exposed area of soil cleared of vegetation, called a form, which resembles a small bird's nest (Dole 1965). The frogs are especially active during night rains, moving onto warm paved roads, through grassy areas, and sometimes travel 100 m (328") before returning to their home habitat (Dole 1965).

**REPRODUCTION:** After the wood frog has finished breeding in late April–early May, the northern leopard frog begins its breeding season. The breeding period for the leopard frog lasts 7 to 28 days, during which non-territorial males call in dense groups in shallow water, often actively searching and struggling for females (Wells 1977b). Mating usually occurs at night and amplexus is pectoral, usually not lasting more than 24 hours. Flattened oval shaped egg clutches 7.5–15 cm (3–6") by 5–7.5 cm (2–3") are laid in communal masses in the vegetated shallow water of lake inlets, slow streams, ponds, or overflows (Wright and Wright 1949). Each clutch may contain 2000 to 4000 eggs. Each egg is approximately 1.6 mm (.06") in diameter and surrounded by a gelatinous envelope approximately 5 mm (.25") thick. Each egg is half black (animal pole) and half white (vegetative pole). Wood frog eggs contrast in that the vegetative pole is not entirely white (Wright 1914). Leopard frog egg masses benefit by being warmer than the water temperature due to the solar absorptive character of the black half of the egg and the insulating effect of the jelly envelope. This is an important adaptation in our cool northern climate where the seasons for development are shorter (Hassinger 1970). Eggs hatch in 13–20 days and transformation takes place 60–80 days after hatching. Newly transformed froglets are approximately 2–3 cm (.7–1.3") in length from snout to vent. Ryan (1953) has documented that between transformation and hibernation, juvenile frogs in New York grow 2.2 cm (.9") or more. The most growth (8–9 mm) occurs in midsummer; growth slows in September (2–6 mm). Sexually mature males grow 8 to 20 mm within a season (Ryan 1953). Young frogs disperse overland to establish residence at new locations, often moving through dry wooded

## *Northern Leopard Frog*

upland areas during warm rainy weather (Dole 1972). Breeding may occur one year after transformation, but two years from the egg stage is more typical.

**DIET:** Tadpoles glean algae and small fauna from substrates such as the undersides of submerged plants. Beetles available throughout the active season (April to October) are a staple constituting more than 50% of the diet for adults and juveniles (Linzey 1967). Otherwise, the diet is composed of insects, spiders, snails, slugs, worms, leeches, and vegetative matter (see Linzey 1967 or Knowlton 1944 for a detailed account of the diet).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Other than its use in science, the northern leopard frog has been considered an "important contributor to the frog leg dinner" (Hamilton 1948). Other animals that prey upon the northern leopard frog include the common garter snake, (Lagler and Salyer 1945), fish such as bass and pickerel, and other anurans such as bullfrogs. Excessive collection of northern leopard frogs has lead to a decline in the species (Bagnara and Frost 1977). To ensure the species' continued existence, efforts to control the harvest of northern leopard frogs are worth supporting.

Steve Hinshaw, University of Maine, Orono

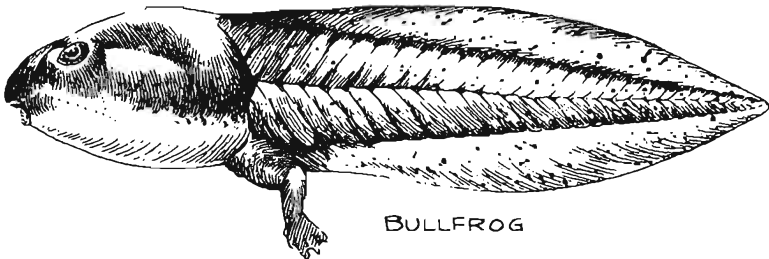
Currently: Division of Biology, University of Missouri, Columbia



WOOD FROG



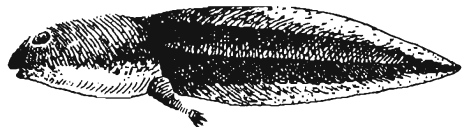
AMERICAN TOAD



BULLFROG

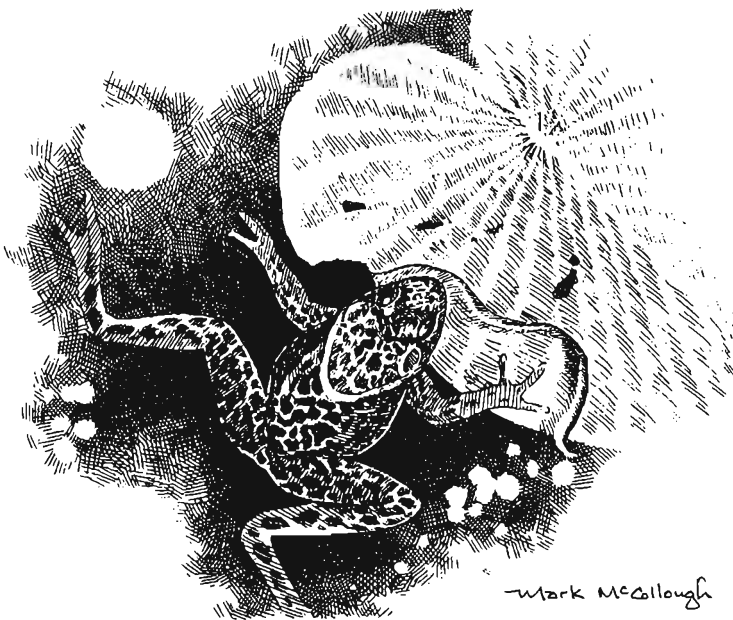


SPRING PEEPER



LEOPARD FROG

*Mature tadpoles (actual size).*



## MINK FROG

*Rana septentrionalis*

*Rana septentrionalis* or "the frog of the north," is commonly called the mink frog because adults emit a musky, mink-like odor when handled. It is truly the frog of the north, being restricted to areas north of 43° North latitude from Maine west to Minnesota, and extending into northern Ontario, Quebec, and Labrador. No other North American frog has such a northerly southern range limit. Mink frogs are almost entirely aquatic and quite secretive, so unless you particularly enjoy wading through lily pads, you are not likely to bump into one. Next time you are out searching for green frogs, startle your friends by encouraging them to smell each captive in the hopes of finding that elusive, musky-smelling "frog of the north."

**DESCRIPTION:** The most distinguishing characteristic of the mink frog is its mink-like odor. Otherwise it can easily be confused with the green frog: the dorsum is an olive green and is spotted or mottled with dark, irregular-sized markings. Dark markings on the hind leg of the mink frog, however, tend to parallel the long axis of the legs rather than run across the legs as they do in the green frog. Furthermore, webbing on the toes of the hind feet extends to the last joint of the fourth toe and to the tip of the fifth toe in the mink frog, but rarely passes beyond the second joint of the fourth toe, and never reaches the tip of the fifth toe in the green frog. The ventral surface

## Mink Frog

of the mink frog is grayish white, but pale yellow may appear on the lower sides and chin of some individuals. Dorso-lateral ridges may be absent, partially developed, or prominent, and are thus not useful for distinguishing this species from other Maine frogs.

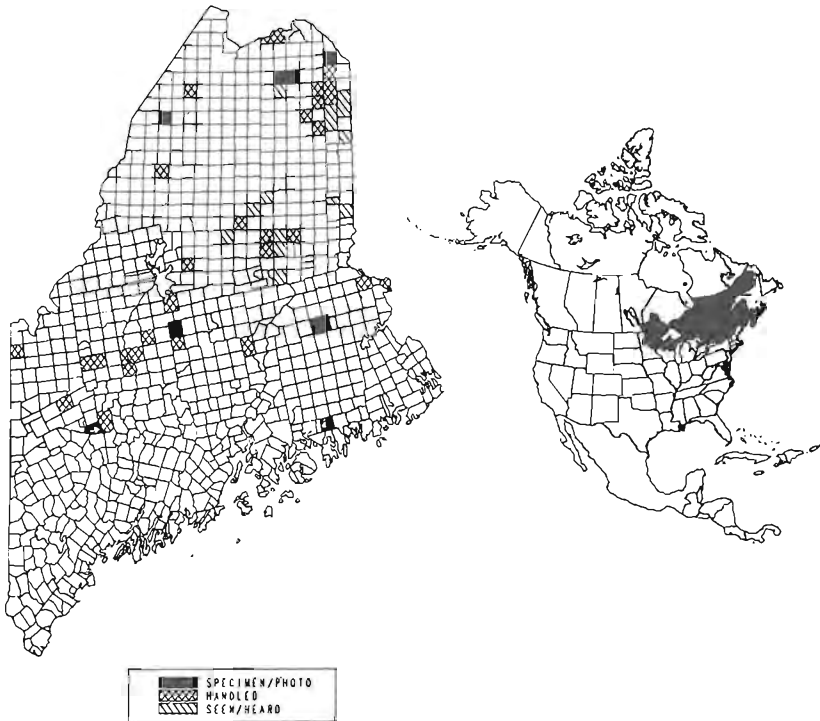
Adult mink frogs range from 4.5–7.6 cm (1.8–2.9") long. Males usually reach sexual maturity less than one year after metamorphosis, when they are between 4.5–5 cm (1.8–2.0") long, but females do not reach sexual maturity until they are 5.4–5.9 cm (2.2–2.3") long, which may be either one or two years after metamorphosis. If the snout-vent length is at least ten times greater than the diameter of the tympanum, then the frog is a female; if the snout-vent length is less than ten times greater than the tympanum diameter, then the frog is a male (Hedeen 1972a). Any frog less than 4.8 cm (1.8") long is considered a subadult and cannot be accurately sexed.

Mink frog larvae grow up to 10 cm (4") long. The dorsum is olive brown or greenish and is covered with small, dark spots. The belly is an opaque straw yellow. The sides are mottled. The elongate tail has an acute tip, is paler than the dorsum, and is marked with irregular-sized dark blotches (Hedeen 1977).

**VOICE:** Descriptions of the song of the mink frog provide a good example of how difficult it is to describe a complex sound in words. The mink frog's *chant d'amour* has been described as "a rapid squeaky croak"; rendered as "cut-cut, gh-r-r-r"; likened to "the sound produced by striking a long nail on the head with a hammer, driving it into heavy timber"; and compared to the song of a green frog, "but higher and slightly metallic."

**DISTRIBUTION AND STATUS:** The mink frog occurs in the northern part of Maine (north of 44° 30') except for one unconfirmed record from Bridgton, and thus it breeds north of the southern boundary of the humid cold region (Hedeen 1986). The southern boundary of the humid cold region extends from eastern Manitoba south to central Minnesota and east in an arc to central New Brunswick. Throughout the humid cold region, the warmest mean monthly temperatures are less than 21.1°C (70°F), and mean annual aridity indices are less than 25% (Eagleman 1976). Water temperature probably restricts the mink frog from breeding farther south; the cool, oxygen-rich water of the north is essential for the embryos to develop properly (Hedeen 1986). In warmer water, oxygen cannot diffuse to the embryos at the center of the egg mass; after those embryos die they emit decomposition products that are toxic to the other embryos in the egg mass.

**HABITAT:** Mink frogs are almost exclusively aquatic, venturing on land only during or immediately after a heavy rainfall (Hedeen 1986). They desiccate easily compared with other frogs of Maine, so they cannot tolerate even semi-damp conditions. Mink frogs use a variety of aquatic habitats, including ponds, lakes, and streams. Because mink frogs hide and hunt among vegetation far from shore, they prefer shallow water with abundant



emergent vegetation, especially floating lily pads and pickerel weeds. If disturbed, mink frogs dive underwater and conceal themselves in submerged vegetation or bottom mud (Hedeen 1972b). After 30 seconds to a half hour, they return to the surface exposing only their eyes and snout. Mink frogs hibernate in the bottom mud of permanent bodies of water.

**REPRODUCTION:** Mink frogs breed in permanent water bodies from late June to early August. Many males may gather in the same areas to form a chorus. Males generally call at night while floating at the water's surface or from amid beds of floating and emergent vegetation. Males call throughout the breeding season, but will move to various calling sites during the season. Females and sexually immature subadults inhabit shallow, often temporary pools of water during the breeding season. Females visit the breeding area only briefly to mate and spawn.

Mink frogs deposit their eggs in a globular, jelly mass, which they attach to submerged vegetation, especially the stem of spatterdock or water lily. The egg mass ranges from 7.5–15 cm (3–6") in diameter and may contain up to 500 eggs. Some time after laying, the egg mass drops to the bottom of the pond or stream where the eggs complete their development. There are no records of the length of time needed for eggs to develop before hatching. The larval stage lasts for about one year, and then tadpoles metamorphose

into frogs during July and August, when they are between 2.8–4.2 cm (1.1–1.7") long.

**DIET:** Tadpoles feed primarily on algae, but fast once the forelimbs appear and the mouth begins widening (Hedeen 1972c). Tadpoles begin eating an adult diet when the tail is less than 2.1 cm (0.8") long (Hedeen 1972c). Adults feed on aquatic organisms that are common at the water's surface, such as dragonflies and damselflies, diving and whirligig beetles, waterbugs, and aphids (Hedeen 1972c; Kramek 1976). They also will occasionally eat minnows, leeches, snails, millipedes, and spiders. Their diet differs from other Maine frogs, which feed primarily on terrestrial invertebrates, but this reflects their habitat preferences rather than specialized feeding behavior (Hedeen 1972c; Stewart and Sandison 1972). Vegetation, especially duckweed, may be accidentally ingested while capturing other organisms (Hedeen 1972c).

Mink frogs may capture prey while either sitting atop lily pads or from a nearly submerged position in the water. When sitting on lily pads, mink frogs attack prey with varying degrees of effort, probably depending on their hunger level (Kramek 1976). When actively hunting, the frogs orient toward larger prey, especially dragonflies and damselflies, that are up to 3 m (3.25') away, swim slowly toward the prey, then quickly lunge at the prey to capture it. At medium activity levels, frogs sit up and wait for prey organisms to come within easy attack distance, continually moving to new hunting places if they are unsuccessful. At low activity levels, frogs remain stationary and only attack prey that come within easy striking distance. When feeding from just beneath the water's surface, a mink frog will orient its body toward the prey, swim slowly toward the prey using only its hind legs for kicking, then finally lunge at and capture the prey (Hedeen 1972c).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Despite their musky smell, mink frogs are eaten and attacked by a variety of other animals (Hedeen 1972a). Tadpoles are eaten by great blue herons and green frogs, and adults fall victim to herons and raccoons. Giant water bugs and leeches also prey upon both larval and adult mink frogs. Even the bacteria *Aeromonas* can infect mink frogs with a fatal disease known as red leg.

Few Mainers have probably come across the mink frog since they are a relatively secretive, aquatic frog, restricted to the northern portions of Maine. However, in the proper habitat, mink frogs can be quite common.

Sarah S. Stockwell, Maine Audubon Society, Falmouth, Maine



Mark McCollough

## WOOD FROG

*Rana sylvatica*

When melting snow and spring rains begin to saturate the ground, the inconspicuous wood frogs rouse from hibernation and begin their annual migration to the breeding ponds. Although other species, like the spring peeper, may be more familiar as harbingers of spring, wood frogs are actually the first to appear. They are remarkably cold-adapted, and it is not unusual to find the earliest migrants swimming where ice remains in the water nearby. That obvious hardiness may be one reason why the wood frog ranges farther north than any other North American species of amphibian. They are found in a broad band of territory stretching from Labrador to Alaska. The northern limits of their range are still not clearly defined, but may extend to the tree line at the edge of the Arctic tundra.

**DESCRIPTION:** Wood frogs are among the smaller Maine ranids, with adults seldom exceeding 6 cm (2.4") in body length. The most distinguishing feature of the wood frog is the dark mask running backward from the eye, over the tympanum, to the angle of the jaw. Below the mask there is a white line along the upper lip. Dorsal color during the breeding season ranges from very dark reddish or chocolate brown to pale pinkish tan. In terrestrial habitat during the rest of the year, these colors may be somewhat muted and have a noticeable grayish undertone. The skin is smooth and there are no



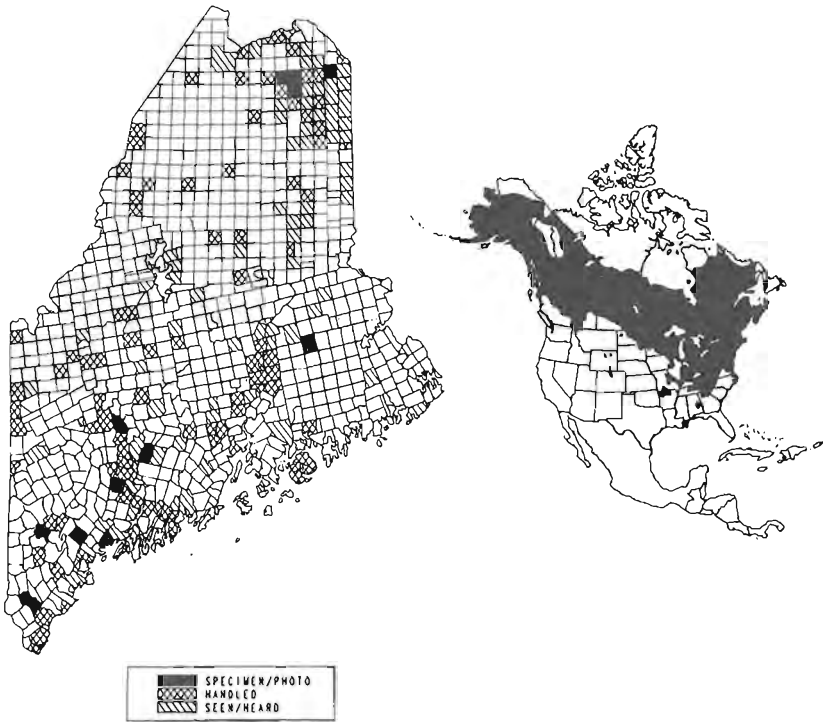
spots on the back. The lower sides may have scattered dark flecks, and there are three or four dark transverse bars on the hind legs.

The dorso-lateral folds are prominent and nearly complete, extending from above the tympana to near the vent. The venter is usually clear, glistening white, but the throat and breast may be sprinkled with dark flecks. The sexes can be distinguished by the shape of the webs between the hind toes, which are convex in males and concave in females. Breeding males also have thickened pads at the base of each thumb. Females are much lighter in color and larger than males. Tadpoles may be identified by having a cream-colored line near the upper jaw and a venter with a striking pinkish bronzy iridescence.

**VOICE:** The advertising call is a short, abrupt “wrunk” sound, which is accompanied by momentary inflation of moderately large, bilateral vocal sacs located above the forelegs. Calls are emitted singly, or in a ratchety string of several notes in rapid succession. They have limited carrying power and can seldom be heard far from the pond (Gerhardt 1975). The sound has often been likened to the quacking of ducks. Large choruses can create the impression of a continuous rattling sound.

**TAXONOMIC STATUS:** Earlier authorities recognized three subspecies of wood frogs (Breckenridge 1944; Wright and Wright 1949). The most common form, which matched the description given above, was classified as *Rana sylvatica sylvatica*. Another form, found in more northerly latitudes, was called the northern wood frog (*Rana sylvatica cantabrigensis*). Until 1946, the latter was unknown south of the Gaspé Peninsula in Quebec, but in May of that year it was discovered near Presque Isle in northern Maine (Wright and Wright 1949; Knox 1960). Although they still listed the subspecies separately, some herpetologists were even then suggesting that subspecific status should be withdrawn (Grant 1941; Wright and Wright 1949). Most authorities today classify all wood frogs simply as *Rana sylvatica* (Behler and King 1979; Conant 1975). The visibly different “northern” form is described here for the benefit of those who may encounter it, particularly in Aroostook County.

The “northern wood frog” is similar to other *R. sylvatica* in general color and markings, but is often visibly grayer. The most striking difference is the presence of a narrow, light-colored mid-dorsal stripe from snout to vent, and similar lengthwise stripes on the femur and tibia of each hind leg. Some specimens exhibit only partial mid-dorsal stripes, and others may lack the stripes on the hind legs (Knox 1960). The striped “northern forms” of the wood frog are significantly less common than the more familiar variety, constituting only 12% of all wood frogs seen, handled, or collected by Knox (unpubl. data) in Aroostook County from 1982 through 1987. Earlier herpetologists stated that the northern subspecies, with or without stripes, could be reliably distinguished by their supposedly shorter hind legs.



However, the current consensus is that the generally stockier build of northern animals is simply an expression of environmental influence on genetic selection. Unfortunately, misconceptions arising from the old theory persist. One popular field guide still erroneously claims that northern "specimens [of the wood frog] resemble toads in appearance and hopping abilities" (Conant 1975). Wood frogs are not particularly accomplished jumpers, but they certainly do not hop like toads.

**DISTRIBUTION AND STATUS:** Wood frogs appear to be common throughout Maine and have been recorded in all of the state's sixteen counties. Wood frogs were by far the most frequently captured species in two studies, based on pitfall traps, undertaken in Maine peatlands (Stockwell and Hunter 1989) and forests (Stockwell and Albright unpubl. data). Present records of occurrence of the "northern" form are confined to a relatively small area surrounding the original discovery site near Presque Isle in northern Aroostook County. More data are needed to determine the southern limits of its range in Maine.

**HABITAT:** Wood frogs are entirely terrestrial except during the breeding season. They breed in semi-permanent pools or in grassy ditches, cattail swamps, old gravel pits, or hollows in alder thickets that are temporarily flooded by spring rains. These sites are usually within or near wooded areas.

In summer, wood frogs range widely in cool, moist woods, where they are active both during the day and at night. Winter hibernation sites are found in rotting logs and stumps, and under rocks, thick mats of moss, or decaying leaf litter in the woods.

**REPRODUCTION:** Wood frogs are one of the few Maine species known as explosive breeders, which refers to their habit of completing the entire sequence of appearance, mating, egg laying, and return to the terrestrial habitat in a very short time. Though the onset of the cycle is evidently weather-related and variable, its duration is relatively constant. In 1987, for example, an exceptionally early period of warm spring weather caused wood frogs in northern Maine to appear 12 days earlier than usual. Sixteen days later, severe cold weather returned, bringing sleet, 5–7" of snow, and freezing temperatures. By then the breeding cycle had already ended and only a few stragglers remained in the ponds. The cold had no perceptible effect on the breeding season and evidently did not delay egg development because hatched tadpoles were seen six days after the snowstorm, or 21 days after the wood frogs had first appeared (Knox unpubl. data). The average time required for development to the hatching stage is 20 days.

Wood frogs normally appear and begin breeding in late March or early April in southern Maine and near the end of April in the north. During migration, they may be guided by a combination of auditory, olfactory, and visual cues. Certainly the calls of the first arrivals at the breeding pools are a strong attraction to others, but they must also locate the site by other means. In related species, odors from the water seem to be a major attractant (Martof 1962b; Oldham 1967; Dole 1968). It has also been shown that some frogs orient themselves directionally in response to celestial cues, particularly the sun, and some species also respond to stellar patterns or the moon (Ferguson 1967). Pools in depressions usually have a surrounding humidity gradient to which the frogs may also respond when nearing their goals.

Calling, mating, and egg laying occur mainly in the early night hours and gradually diminish toward dawn, but may continue during the day in undisturbed locations (Wright and Wright 1949; Gilhen 1984). Males tend to congregate afloat in a single small area of the pool, where they vocalize to attract females. The males investigate and attempt to embrace every potential mate that is detected by sight or water disturbances (Lewis and Narins 1985). Gravid females may be recognized by their greater girth and firmness (Wells 1977c) and the absence of audible protest. Males are known to prefer the larger females (Berven 1981). At any given time there are more males than females and only about 20% of males succeed in finding a mate (Howard and Kluge 1985). These factors sometimes result in many males clinging determinedly to a single female in a desperately struggling mass. Males have even been seen clinging to spotted salamanders. When mating, the male clings tightly to the female's back (dorsal amplexus). Visible contractions of the female's body signal the onset of oviposition, at which

time the male's hind feet are drawn up close to the female's vent. As the eggs are expelled, the male releases sperm into the water and strokes the egg mass with his hind feet, which presumably aids in distributing the sperm more evenly. It may also assist in expelling the eggs and attaching them to submerged plant stems or branches. When oviposition is completed, the male disengages and swims away almost immediately, but the female appears comatose and sinks to the bottom to remain inert for an extended time (Knox unpubl. data).

The clear jelly capsules surrounding the eggs expand by water absorption, and the globular clutch soon attains several times its initial size. An average clutch measures 6–10 cm (2.5–4") in diameter and contains about 1,750 eggs (Duellman and Trueb 1986). Isolated individual clutches are seen occasionally, but most are deposited in large communal masses, which are confined to a single area of the pool and may consist of more than one hundred separate clutches. This strategy has been shown to provide survival advantages through reduced predation, heat retention (Hassinger 1970; Herreid and Kinney 1967; Waldman 1982), and delayed desiccation if the eggs are stranded by diminishing water levels (Knox unpubl. data). Egg development may also be enhanced by solar heat accumulation resulting from a lens-like effect of the spherical jelly capsules (Bragg 1964). The temperature in the center of communal egg masses can be as much as 1.6°C warmer than the surrounding water (Hassinger 1970; Herreid and Kinney 1967; Waldman 1982). The eggs are velvety black or chocolate above and ivory white below. They measure about 1.9 mm in diameter and are each enclosed within two closely spaced vitelline membranes and a larger outer jelly capsule. The jelly portion is usually clear, but may have a bluish tint. By hatching time, the jelly often becomes semi-opaque and overgrown with algae, which may assure early sustenance for the young tadpoles without requiring them to leave the protection of the jelly mass. The rate of embryo development is partially dependent on water temperature (Herreid and Kinney 1967; McLaren 1965), but most hatch, as previously noted, in about 20 days (Stebbins 1951). Pollister and Moore (1937) claimed that wood frog tadpoles hatched in as little as 90 hours at a water temperature of 18.4°C (65.1°F). Such rapid development is highly unlikely, however, in springtime field conditions in Maine.

Newly hatched larvae measure 7–9 mm in length. As they grow, their color lightens from velvety black to a mottled olive brown (Altig 1970). Metamorphosis occurs an average of 67 days after hatching (Stebbins 1951), or from late May to mid-August in Maine. Transforming juveniles are faithful miniatures of the adults in regard to color and markings. Large numbers of these tiny (1–1.2 cm) frogs congregate under shore litter and vegetation before dispersing into surrounding terrain. Most of them (70% or more) succumb to predation and other natural hazards before reaching adulthood (Stebbins 1951). Surviving males attain breeding size and return to the ponds in 1–2 years, but most females do not breed until they are two

years old (Berven 1981; Collins 1975). There is evidence that wood frogs, like some related species, have strong homing instincts and return to the same ponds year after year (Oldham 1967).

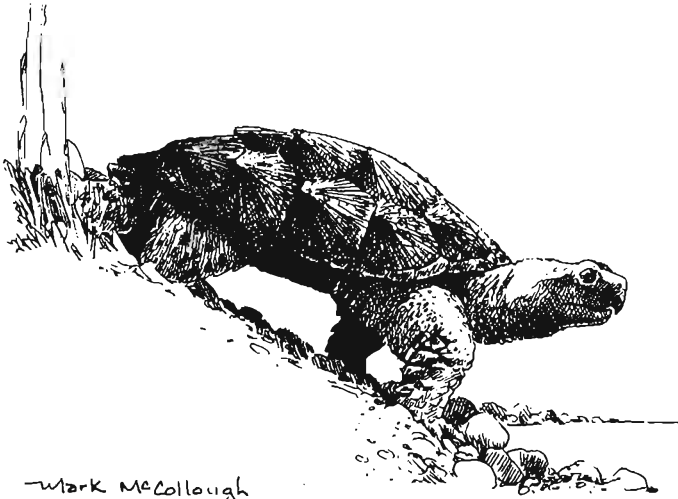
**DIET:** Young tadpoles feed on algae and various microorganisms scraped from aquatic vegetation with their specialized rasping mouth parts. As they grow older and larger, decaying plants and some animal matter are also consumed. Gilhen (1984) found that adult wood frogs in Nova Scotia consumed a wide variety of small invertebrates, including spiders, beetles, bugs, moth larvae, earthworms, slugs, and snails.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Wood frogs fall prey to a variety of other animals. Some adults are caught in the breeding ponds by water snakes, snapping turtles, herons, mink, and raccoons. On land they are vulnerable to snakes, skunks, foxes, coyotes, and some larger birds. Leeches, mayfly larvae, and salamanders feed on the eggs. Tadpoles are eaten by diving beetle larvae (Young 1967) and *Ambystoma* salamanders (Caldwell et al. 1981). Studies in Alaska showed that only 4% of wood frog eggs and larvae survived such onslaughts (Herreid and Kinney 1967). Mass mortality of wood frog larvae due to bacterial infection has also been documented (Nyman 1986). When breeding pools dry up prematurely, stranded tadpoles are decimated by wading, shore, and land birds. Active newly transformed juveniles are attractive prey for larger frogs as well as snakes and birds (Arnold and Wassersug 1978; Gans 1961; Smith 1977).

Except for simple flight and concealment, wood frogs have few defenses against these assaults. Loud distress cries might induce release by a startled predator (Duellman and Trueb 1986) and rigid body inflation—a common response to handling (Knox unpubl. data)—could make them more difficult to grasp or impede their being swallowed (Duellman and Trueb 1986). There is experimental evidence that shows metamorphosing wood frogs develop granular skin glands that secrete noxious substances (Formanowicz and Brodie 1982).

Wood frog populations are directly affected in some areas by habitat destruction resulting from urban sprawl, commercial development, forestry practices, and highway maintenance procedures. The breeding site where the northern wood frog was initially discovered in Maine was obliterated when a cedar swamp was cut and filled for commercial construction. Elsewhere, a larger alder swamp utilized by hundreds of breeding amphibians was completely drained by highway crews deepening ditches and installing culverts. In two cases, the development of wood frog and spotted salamander eggs was apparently arrested by runoff of highway salt that was heavily applied during late spring ice storms. In another instance, an old beaver pond was virtually abandoned as a breeding site after the surrounding forest was clearcut almost to the water's edge.

Carroll B. Knox, Caribou, Maine



## SNAPPING TURTLE

*Chelydra serpentina*

Snapping turtles are well known because of their pugnacious behavior when encountered on land, and from tales of their predatory habits. Not as well known is their shy and retiring nature when in water. Snappers often lie in the shallows or float near the surface with only their eyes and nostrils protruding. At the slightest hint of danger, they quickly submerge to the bottom. Even a large, old mossback may disappear with scarcely a ripple.

By most standards, snapping turtles are not beautiful. But biologically, they are remarkable, having evolved 60–100 million years ago. Many other creatures have perished, but snapping turtles and some other reptiles continue to thrive despite the awesome habitat changes created by a comparatively new species—*Homo sapiens*.

**DESCRIPTION:** The snapping turtle's rough, blackish brown or rich mahogany carapace is somewhat oval, but slightly wider posteriorly. The posterior margin is strongly serrated. Algae growing on the shell may produce a greenish gray instead of dark brown color. Three low keels along the back are noticeable in all but the largest individuals. The tail is usually at least as long as the carapace and is distinctive because of its prominent, saw-toothed ridge formed by raised bony plates. The cross-shaped plastron is dull yellow or olive gray. It joins the carapace on each side only at a narrow,

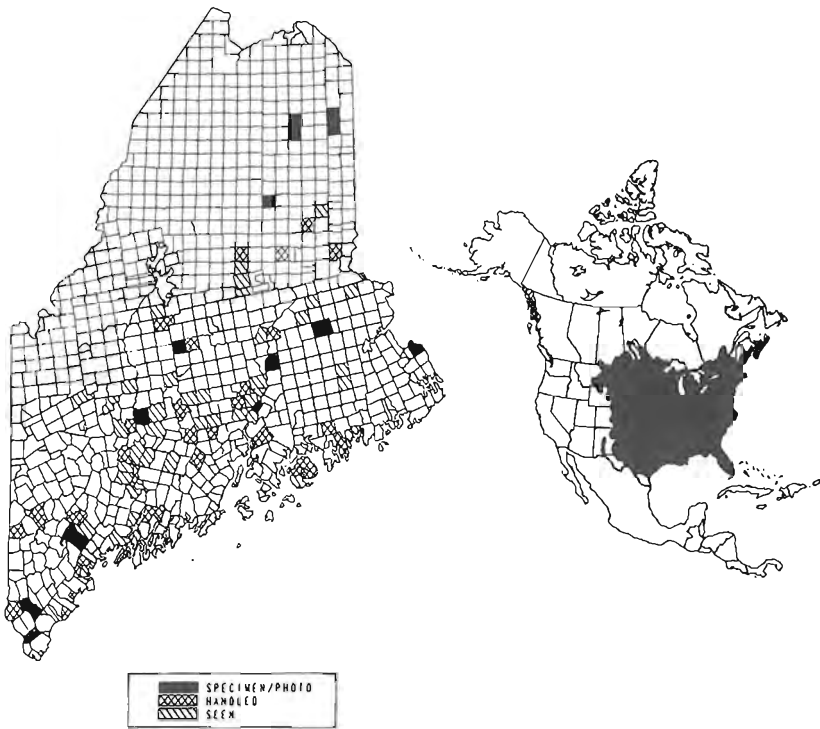
fixed bridge. The carapace and plastron only partially cover the body and appendages. This is an easy way to tell snappers from other Maine turtles. The skin is dark on dorsal surfaces and lighter on the under sides. Rounded, wart-like tubercles cover the skin, especially on the dark head and neck. Twin barbels are located on the chin. The muscular legs each have 5 sharp, curved claws.

The average snapping turtle in Maine weighs 7.7–9.0 kg (17–18 lbs). Weights for 177 Maine specimens ranged from 1.1–21.7 kg (2.5–48.0 lbs). Twenty turtles exceeded 13.6 kg (30 lbs), 5 of these were 18.1–21.7 kg (40–48 lbs) (Coulter 1958). The carapace from turtles that weigh 18.1 kg (40 lbs) or more may measure 46 x 36 cm (18 x 14"). With head, neck, and tail extended, these individuals are 92 cm (3') or more long. There are unverified reports of larger snapping turtles from Maine. Elsewhere, occasional 27–32 kg (60–70 lbs) snappers have been reported (Carr 1952). In July 1988, John Rogers, a professional turtle trapper from Maine, caught and released a new world record snapping turtle in the wild in Middlesex County, Massachusetts. The huge male weighed 30.5 kg (67 lbs) on certified scales and had a shell length of 50.7 cm (19.8") (Anonymous 1988). All specimens from Maine that weighed 11.4 kg (25 lbs) or more were males. The average male weighed 10.6 kg (23.3 lbs) or about twice the average for females. The only reliable external indicator of sex is the distance of the cloaca from the tip of the plastron. It is relatively longer in adult males than in adult females. Determining sex by this character, however, requires some experience.

**TAXONOMIC STATUS:** The common snapping turtle, *Chelydra serpentina serpentina*, is the subspecies that occurs in Maine.

**DISTRIBUTION AND STATUS:** Snapping turtles are common in southeastern and central Maine, east into Washington County, and north in Aroostook County to Ashland. In western and northwestern Maine, they are found only to the fringe of highlands that traverse the state from southwest to northeast beginning in Franklin County. There are no records of snapping turtles penetrating very far into the northwestern highland, described and named by Toppan (1935) as the Moosehead Plateau. A very similar pattern occurs in New Brunswick where snappers are found in coastal regions and river valleys, but not in the northern highlands (McAlpine and Godin 1986).

The abundance of snapping turtles varies greatly. On the west branch of the Sebasticook River (locally called Corinna Stream), one turtle per 1.6 ha (4 acres) of water was trapped during a study in 1950. The 2-year take in 1949 and 1950 was 103 turtles weighing 454 kg (2,105 lbs). This was an unusually high population density. On many other marshes, the number of snappers, based on sightings of turtles, evidence at nesting grounds, and limited trapping, is much lower. Sightings of snappers are generally not indicative of the population size. They seldom bask on rocks or logs, in contrast to painted turtles. Snapping turtles retreat quietly and often are not noticed by the casual observer. One can reasonably expect to find a few



snapping turtles on almost any waterway within their range in Maine, but high numbers occur only in the best habitats.

**HABITAT:** Snapping turtles may be found in any marsh, stream, or lake, and even occasionally in brackish water. Ideal habitats appear to be shallow fresh marshes, sluggish meandering streams, and marshy coves along lakes. In these soft bottom habitats, the omnivorous snapper finds easy foraging upon an abundance of prey species as well as the sprouts and shoots of tender aquatic plants. They are active from late May to October and hibernate in bottom sediments during the colder months.

Individuals may occur in fast-flowing, rocky streams, sandy bottom lakes, or in deep waters with little aquatic vegetation. In Maine, however, snapping turtles are never very abundant in such habitats.

**DIET:** Several studies throughout the snapper's range have shown that they eat a surprising variety of plants and animals. Maine specimens contained yellow perch, white perch, minnows, suckers, bullheads, pickerel, and other fish. Snails, frogs, grebes, and ducklings provided added variety. And many turtles ate large quantities of the succulent white shoots of cattail or the fleshy basal corms of pickerel weed (Coulter 1957). These turtles hunt by prowling slowly along the bottom, or they lie motionless in the shallows waiting for whatever prey may wander by.



**REPRODUCTION:** The females leave the water during June to dig nests and lay eggs in gravel, sand, light loams, occasionally a sawdust pile, or the decaying vegetation in a muskrat house. Individuals may migrate overland to sites several hundred meters from water. Snappers are commonly seen during June along highways, railroad embankments, dikes, and in gardens and other places with light-textured soil. Radio-tagged females studied in Ontario showed strong fidelity to nesting sites (Obbard and Brooks 1980). They commonly travelled 1–3 km (0.6–1.8 mi) to nest. A few turtles made round trips of several kilometers to gravel fill that created an attractive artificial nesting place in an area where natural sites apparently were not common. Hammer (1969) reported that individuals 25.4 cm (10") long were sexually mature.

The female digs a flask-shaped hole 18–23 cm (7–9") deep with her hind legs. She lays 20–40 spherical, white eggs about 30 mm (1.2") in diameter. The eggs have a tough, somewhat pliable shell. They are buried and left to incubate from the natural heat of the environment. Hatching requires 3 to 4 months. Many nests are destroyed by skunks, raccoons, foxes, and coyotes. Hammer (1969) reported that emergence of hatchlings occurred in only about 20% of the nests. The small turtles often emerged 10–15 days after hatching. Incubation temperature has been shown to control sex determination in the early developing embryos. Warmer temperatures at the critical early stages of development result in female hatchlings. Eggs in nests exposed to full sunlight produced more females than eggs from shaded nests. Sex differentiation also occurs relative to egg position in the nest; those near the top are warmed more than eggs near the bottom and produce more females (Wilhoft et al. 1983). Occasional nests may overwinter and young turtles emerge the following spring (Toner 1933, 1940; Obbard 1981).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Snapping turtles are sold in several parts of the country. The light-colored, tasty meat is a favorite in soups and stews. Turtles are captured by probing for them in muddy bottoms or by using traps baited with fresh fish. In recent years, one commercial trapper has shipped thousands of turtles from Maine.

Contrary to popular notions, swimmers have little to fear from snapping turtles in the water. The snapper's typical behavior in water is to escape. Turtles encountered on land, however, are dangerous if molested. They will strike at any intruder and can inflict painful injuries with their sharp, powerful jaws. Since the neck folds into the shell, the turtle can strike out much farther than one might suspect. When provoked, a turtle can raise itself from the ground and lunge forward when striking. If it is necessary to handle one, it should be grasped by the tail with the plastron toward the observer. Even the tiny hatchlings have the instinct to strike when on land.

Because the diet includes fish and birds, anglers and hunters often regard the snapper as a serious predator. All detailed studies to date show that predation on game fish or birds is minor, unless high numbers of both

turtle and prey exist. Predation may be high in special habitats such as farm ponds or marshes where the prey are confined to a small area. In such instances, it is relatively easy to move the turtles to larger natural areas. Chemical contaminants pose a comparatively recent threat to this ancient creature. Since snapping turtles feed freely at several trophic levels and are long lived, they are prime candidates for accumulating chemical residues. Recent studies have shown high levels of persistent organochlorines in the tissues of specimens from the Hudson River (Stone et al. 1980).

Malcolm W. Coulter, Department of Wildlife, University of Maine, Orono



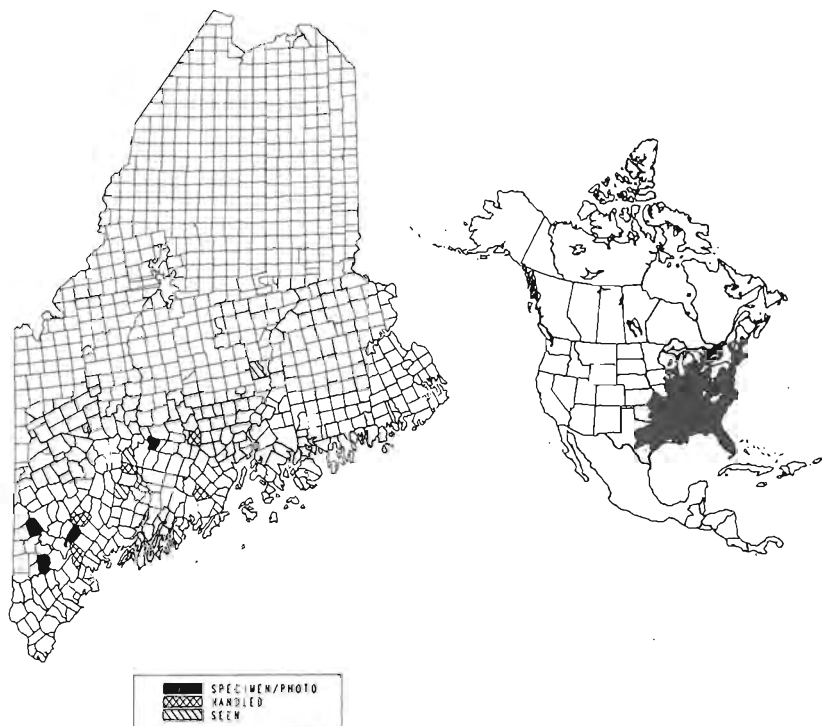


## COMMON MUSK TURTLE

*Sternotherus odoratus*

This feisty terrapin is the smallest of our Maine turtles. Musk turtles have a mean disposition, and when picked up, they give off a pungent odor from four glands near the bridges of their shell. This is the reason for their scientific and common names, including various colloquial versions such as stinkpot, stinking-jim, and skillpot. In 1857, Louis Agassiz described a musk turtle he had kept in captivity for a few weeks: "When taken out of the water, they draw in their heads, just allowing the vicious eyes to be visible, and opening the sharp-edged mouth widely to bite deliberately and furiously at the unwary finger." Because musk turtles are secretive and spend much of their time on the bottoms of lakes and ponds, they can be mistaken for a smooth, oval stone.

**DESCRIPTION:** Adult musk turtles are oval in shape and rarely more than 12.5 cm (5") long. Their carapace is smooth and olive brown or black, but the plastron is relatively small and cream or yellowish in color. The head and neck have two longitudinal light yellow stripes terminating at the tip of the nose. On the bottom of the chin and throat are two sets of "barbels" which are small, fleshy projections used as tactile devices. In Maine, adult males and females are usually the same size, but they can be distinguished by a number of features. Males have a relatively longer and thicker tail with a



horny tip. The plastron of a male has more skin between the scutes, and its head is usually somewhat larger than that of a female. Finally, a male musk turtle has a patch of scaly skin on the inner surface of each hind leg, which is used to hold onto the female while mating with her (Risley 1938).

Juvenile musk turtles look somewhat different from the adults. Their carapace has three longitudinal keels, and there is a light blotch on each of the marginal scutes of the plastron. Juvenile musk turtles also have two light head stripes (Conant 1975) and are sometimes mistaken for juvenile snapping turtles, but snappers have saw-toothed nails, serrated marginal scutes, and a rough carapace.

**DISTRIBUTION AND STATUS:** Maine is the northern limit of musk turtles in the United States. Throughout their range they avoid high elevations, and in Maine their distribution is primarily in the southwest extending east along the coast. Mairs (1962) reported an individual from the Narraguagus River in Beddington, Washington County. They are apparently not abundant anywhere in Maine, and this, coupled with their secretive habits, makes musk turtles difficult to find in most Maine waters.

**HABITAT:** Musk turtles are strictly aquatic and prefer permanent bodies of water such as ponds, shallow lakes, and slow-moving, shallow streams

and marshes (Babcock 1919). They prefer a rather narrow range of temperatures and will move to deeper, cooler water if water temperatures rise much above 24°C (75° F). During the day they bask just below the water surface and spend their mornings and early evenings foraging for food and feeding. In periods of very warm weather in July and August, musk turtles may increase their activity at dusk and dawn and spend most of the day inactive. No feeding takes place when the water temperatures drop below 18°C (64°F) (Ernst 1986), and in the fall, when water temperatures drop below 10°C (50°F), musk turtles begin to search for a place to hibernate a few centimeters under the mud in shallow water (Cagle 1942). The turtles emerge from hibernation in April or May when water temperatures rise once again.

**REPRODUCTION:** Musk turtles reach sexual maturity at different sizes throughout their range. No comprehensive reproductive studies have been carried out on musk turtles in Maine, but, in a well-studied population in Virginia, male musk turtles reach sexual maturity by the time they are two years old (about 5.1 cm [2"] carapace length), although they do not mate until their third year. Females take longer to mature and may not lay their first clutch until their fourth or fifth year (Mitchell 1985). Mating takes place during the spring and fall (Ernst 1986). The eggs remain in the female up to four weeks (Edgren 1960), and when she is ready to lay her eggs, she leaves the water to search for a place to dig a nest. Quite often nesting takes place in the early evening and usually three to nine (Graham and Forsberg 1986) eggs are laid in late June in a flask-shaped nest about 10 cm (4") deep in loamy soil, muskrat lodges, or in rotting stumps.

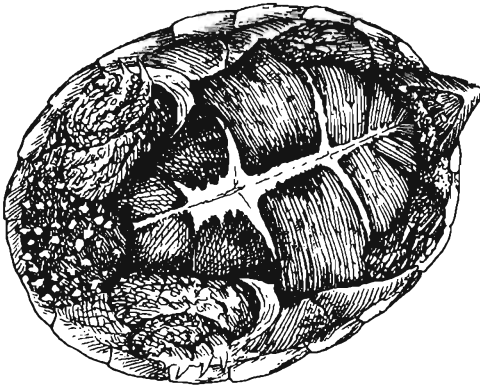
Unlike the leathery, round eggs of snapping turtles, musk turtle eggs are brittle and elliptical in shape. The eggs are white or pinkish in color, measure about 2.5 cm (1") long and 1.4 cm (0.6") wide, and weigh approximately 4 grams (0.16 ounces) (Edgren 1960). After she buries her eggs, the female leaves the nest and returns to the water. Time until hatching depends upon the incubation temperature, but usually it takes between 80 and 100 days until the young emerge from the nest and make their way to the water. The hatching success rate can be very low (15%) due to the high incidence of predation on the nests by birds and mammals (Ernst 1986). Hatchlings are usually only about the size of a dime at birth and are extremely vulnerable to fish and bird predators. A long-term study of a population in Pennsylvania showed that musk turtles can live at least 28 years in the wild (Ernst 1986) and an age of more than 54 years in captivity has been reported (Bowler 1977).

**DIET:** The bulk of the musk turtle diet consists of carrion, small fish, aquatic insects, snails, and small freshwater clams (Carr 1952). They will also feed on algae, leeches, crayfish, and some aquatic plants (Ernst 1986). When the hatchlings first make it to the water, they rely on their absorbed yolk as a food source for the first 3–4 weeks. When they begin to feed, however, they

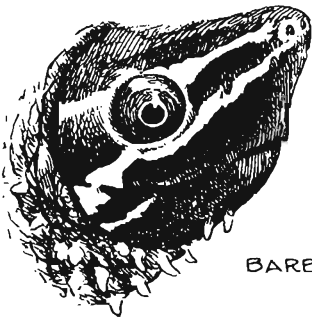
attempt to eat anything small that moves. The young feed mainly on small insects and occasionally small fish.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Historically, musk turtles have been of no economic value to humans, but they do play a major role in the ecosystem as scavengers. The high incidence of egg predation suggests that musk turtle eggs may be an important source of food for some species of mammals and birds. Juvenile musk turtles are eaten by fish, wading birds, otters, skunks, and raccoons.

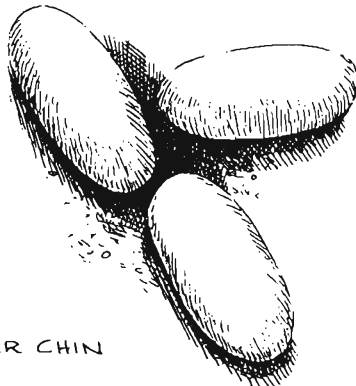
Cory R. Etchberger, Dept. of Biology, Indiana University, Bloomington



PLASTRON WITH  
SKIN BETWEEN  
SCUTES

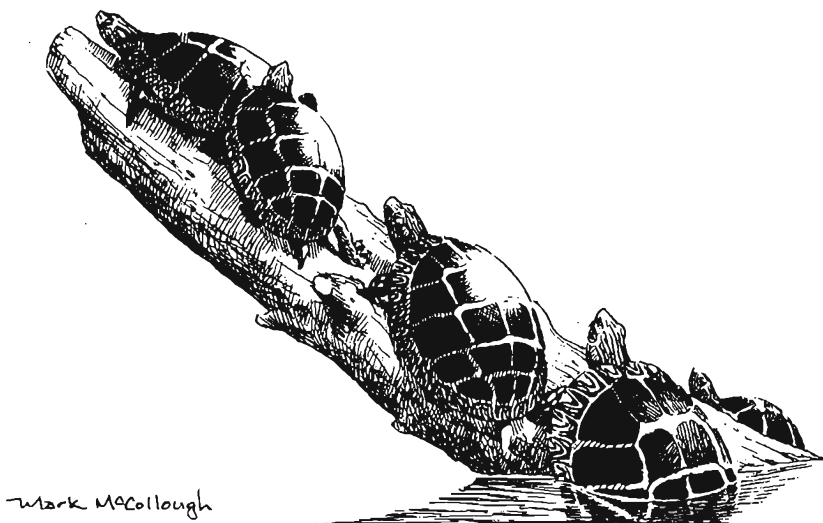


BARBELS UNDER CHIN



ELLIPTICAL EGGS

Mark McCollough



## PAINTED TURTLE

*Chrysemys picta*

The most attractive turtle in Maine is the painted turtle, named for its bright green, red, black, and yellow colors. Moreover, because painted turtles spend much of their time basking on logs or rocks, they are also Maine's most conspicuous turtle. Unfortunately, they are quick to make a hasty retreat to the water when disturbed, and thus most people never come close enough to one to fully appreciate its beautiful markings.

**DESCRIPTION:** The carapace of adult painted turtles is oval, smooth, and reaches a maximum length of approximately 18 cm (7.1"). It is a dark olive color and the large scutes have distinct light margins. The marginal scutes have red markings outlined in black above and below, and the plastron is a pale yellow with an occasional dark blotch. The head and neck are dark olive green with light yellow and red stripes running longitudinally to the tip of the nose (Conant 1975). If you are observing painted turtles from a distance, a feature that can be seen through binoculars is the two yellow spots on either side of the head behind the eye. Unlike both spotted and Blanding's turtles (the two Maine species most likely to be mistaken for a painted turtle) painteds have no yellow spots or flecks on their carapace. The young look similar to adults, but they have a mid-dorsal keel, and the plastron may be salmon or pink in color; both of these features are lost as the turtle matures.

Male painted turtles are smaller than the females. Males are rarely longer than 17 cm (6.75") shell length and females are rarely longer than 18 cm (7.1"). The nails on the front feet of the male are long compared to those of the adult female. In addition, the anal opening of the male opens posterior to the back of the shell margin, and the female opening is anterior to the shell margin.

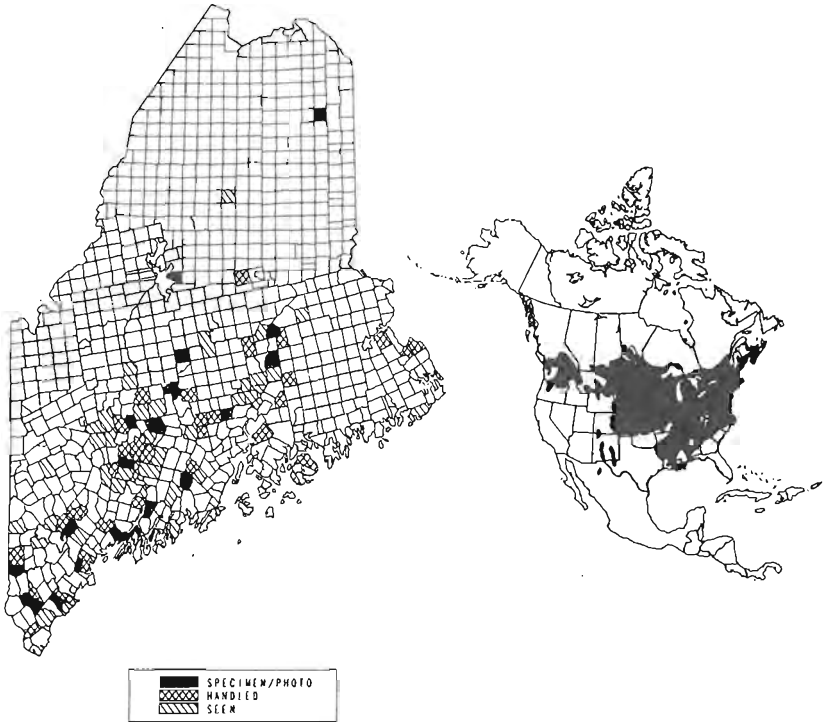
**TAXONOMIC STATUS:** Four subspecies of painted turtles are recognized in the United States. Two of the subspecies live in Maine: eastern painted turtles (*C. p. picta*) and midland painted turtles (*C. p. marginata*). The habits of the two are quite similar. Midland painted turtles look very similar to eastern painted turtles, but they can be distinguished by closely examining the pattern of scutes on the carapace. Midland painted turtles have alternating scutes along the carapace so that the seams of the vertebral scutes do not align with the lateral scutes. The light scute margins of an eastern painted turtle form straight lines across the back. In addition, unlike eastern painted turtles, most midland painted turtles have dark plastral blotches (Carr 1952).

The distribution of midland painted turtles in Maine is unclear. DeGraaf and Rudis (1983) map the range as far north as Moosehead Lake and as far east as about Dover-Foxcroft. Carr (1952), Conant and Collins (1991), and Ernst (1971) only show midland painted turtles as far east as the western edge of Maine. The MARAP project, however, has two records from Brunswick and Westbrook, Cumberland County, plus an unconfirmed report from Bar Harbor, Hancock County. The two subspecies of painted turtles overlap somewhat in their distribution, but it has been suggested that midland painted turtles are able to withstand colder temperatures than eastern painted turtles (Carr 1952). Because of the distributional overlap, intergrades between the two subspecies are common. Certainly a more detailed account of their distribution is needed in the state.

**DISTRIBUTION AND STATUS:** In Maine the painted turtle is largely restricted to areas within about 60 kilometers (40 miles) of the coast, although there are outlier records from near Moosehead Lake and Presque Isle, plus an unconfirmed report from the north end of Baxter State Park. Although frequently seen, painted turtles may not be as common as snapping turtles.

**HABITAT:** Painted turtles prefer quiet shallow ponds, marshes, bogs, and slow-moving streams. They thrive where submerged vegetation and basking areas are abundant. During the evening they sleep on the bottom of a pond or in shallow water among submergent vegetation. Painted turtles hibernate on the muddy bottom of ponds and lakes and are one of the first turtle species to come out of hibernation in spring; they have even been noticed swimming beneath ice. In May, painted turtles may migrate between bodies





of water, sometimes in large numbers, and may even be seen feeding on land (Carr 1952). Although most painted turtles live in freshwater, there are reports of finding them in brackish water (Babcock 1919).

**REPRODUCTION:** Sexual maturity in painted turtles is related to length and not age. Males usually reach maturity by 8 cm (3.25") plastron length (usually 4 years), but may not mate until their 5th year (Ernst and Barbour 1972). Females may take 6–7 years to mature (11 cm [4.4"]). Mating takes place in the spring and fall with the male courting the female in shallow water by moving in front of the female face to face. He strokes her face with the back of his enlarged front claws, then swims away only to return to her again and repeat this procedure. When the female sinks to the bottom, the male mounts her by placing his plastron on top of her carapace, and copulation takes place.

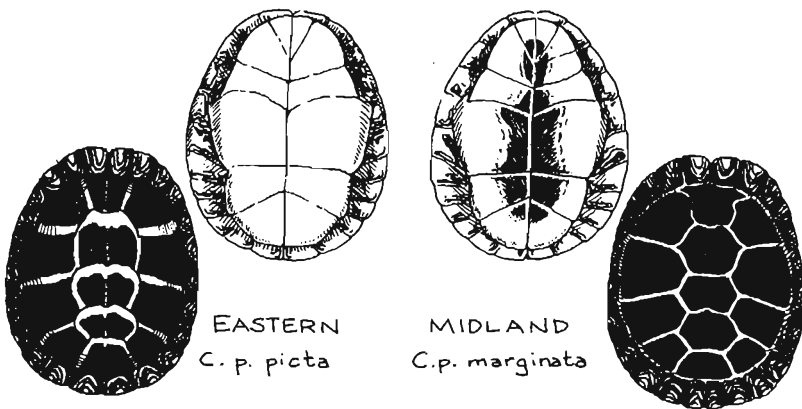
The female will search for a place to nest on land in June or July. She may make an exploratory trip in search of a suitable nest area and may stay on land overnight buried under thick vegetation. Painted turtles seem to prefer to nest during the late afternoon and evening hours, sometimes finishing after dark (Christens and Bider 1987). Five to eleven eggs are laid in a shallow flask-shaped nest the female has dug with her hind legs. Some females may even be able to lay two clutches per year (Powell 1967). The eggs are white and elliptical in shape [about 3.3 cm (1.4") long and 2.3 cm (0.9") wide] and weigh about 7 grams (0.28 ounces). Incubation temperature of the

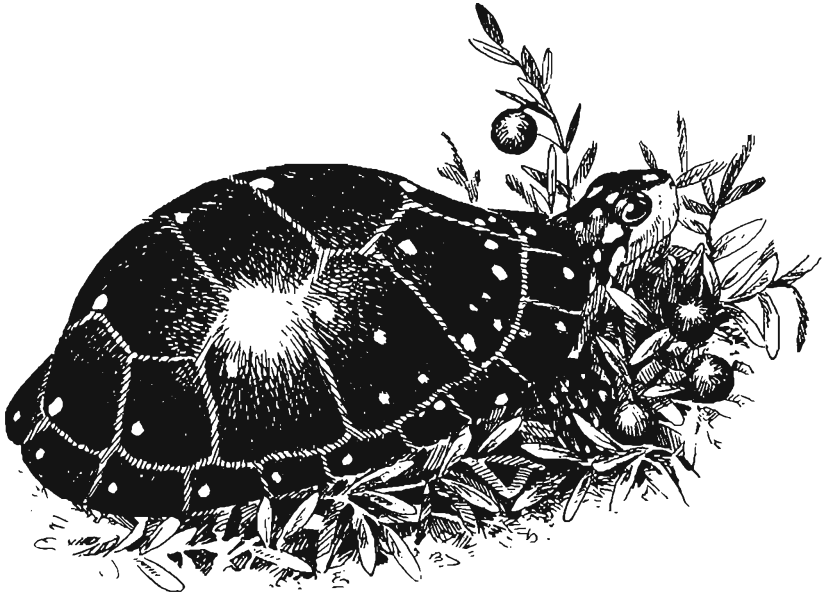
nest determines the time until hatching, but it usually takes at least 65 days. Eggs hatch and the nickel-sized young overwinter in the nest and emerge the following spring (Breitenbach et al. 1984). If there is very little snow cover during the winter, hatchlings may die due to cold nest temperatures (below  $-4^{\circ}\text{C}$  [ $24^{\circ}\text{F}$ ]). If the hatchlings survive the winter, they emerge in the spring when soil temperatures reach  $13\text{--}19^{\circ}\text{C}$  ( $58\text{--}65^{\circ}\text{F}$ ). Hatchling turtles make their way to the water and begin to feed almost immediately. If conditions are favorable during their first year, hatchlings may be able to double their size.

**DIET:** Young painted turtles are mainly carnivorous and become more catholic in their feeding habits as they mature (Ernst and Barbour 1972). Adults feed on aquatic insects, snails, vegetation, crayfish, and even carrion. They search for food by prowling along the muddy bottoms of shallow ponds or streams and thrusting their heads into vegetation to scare out potential food.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Painted turtles have not been of much economic value, but people in some parts of the United States apparently eat the flesh and eggs of painted turtles. The most common human use of painted turtles is in school laboratories as experimental subjects. Many mammals feed on painted turtle eggs, and fish and large wading birds take young turtles in the water. As adults, most painted turtles probably escape harm, except for predation by an occasional raccoon or mortality by vehicles. Painted turtles are somewhat tolerant of industrial waste and are sometimes found in polluted habitats.

Cory R. Etchberger, Department of Biology, Indiana University, Bloomington





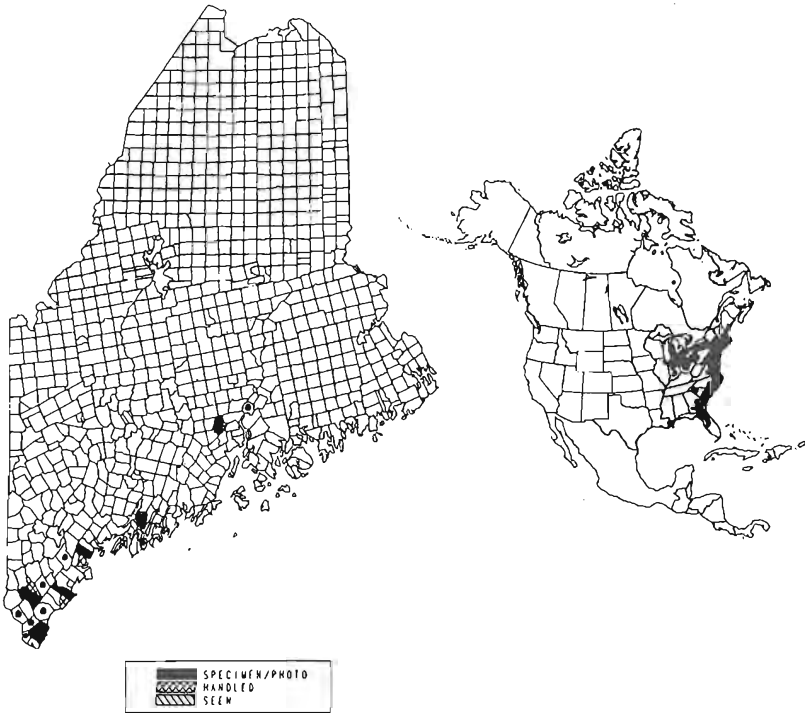
Mark McCollough

## SPOTTED TURTLE

*Clemmys guttata*

Its secretive nature, limited distribution, and fairly specialized habitat requirements make the spotted turtle one of our least observed and studied reptiles. Although the diminutive spotted turtle is seldom seen in spite of its distinctive coloration, when it is discovered it is quite easily captured because its typical habitat, small shallow pools, offers little protection from people.

**DESCRIPTION:** The spotted turtle is a relatively small turtle 8.0–12.5 cm (3.2–5"), which gets its name from the bright yellow spots that dot its smooth, low, black carapace. These distinct yellow dots and the low carapace distinguish the spotted turtle from the Blanding's turtle with its flecked, domed shell. Often, only their heads can be seen above the water, but with practice, using binoculars, they can be differentiated from painted turtles by the lack of a yellow eye stripe. The number of spots varies considerably among individuals; they are as unique as a fingerprint and can be used to differentiate between individuals (Carroll 1991). Sexual variation is similar to that of other turtle species, in that male characteristics include concave plastrons and longer, thicker tails. Also, males have tan chins while females are more brightly colored with yellow chins and orange eyes.



**DISTRIBUTION AND STATUS:** Historically the spotted turtle has been considered rare in Maine (Verrill 1863), although Babcock (1919) considered it one of the commonest chelonians of New England. MARAP records were concentrated in coastal communities from York to Woolwich, with scattered occurrences as far north as Mercer and from Monroe to the east. In 1991, a spotted turtle was captured in Orrington, extending their range east of the Penobscot River. Although widely distributed in southern and central Maine, most records are of single individuals; it is probably moderately common in only a limited portion of extreme southwestern Maine. The spotted turtle is listed as a Threatened species by the Maine Department of Inland Fisheries and Wildlife.

**HABITAT:** Spotted turtles are generally characterized as aquatic, although they are frequently found wandering over land (Ernst and Barbour 1972). In Maine they have been found in unpolluted, small, shallow wetlands surrounded by dense vegetation such as slow streams, ponds, vernal pools, bog ponds, roadside ditches, and wet meadows (Haskins unpubl. data). They often cryptically bask along the water's edge, in brush piles, overhanging vegetation, and sphagnum mats and hide in mud and detritus when disturbed. In the north, they hibernate on the bottoms of wetlands during the coldest winter months. In Maine, radio-tagged individuals readily travelled as much as half a kilometer overland between wetlands to take

advantage of ephemeral food sources. Habitat requirements for the young are unknown and few young spotted turtles have been observed in Maine. Haskins (unpubl. data) observed Maine spotted turtles nesting in sandy roadsides and dried sphagnum on the margin of a fen, although in nearby New Hampshire they also nest in sandy-loam soils in agricultural fields and disturbed areas (Carroll 1991). The home range sizes of adult turtles may average 2 to 3 hectares (5–7 acres), but probably vary greatly (Ernst 1970).

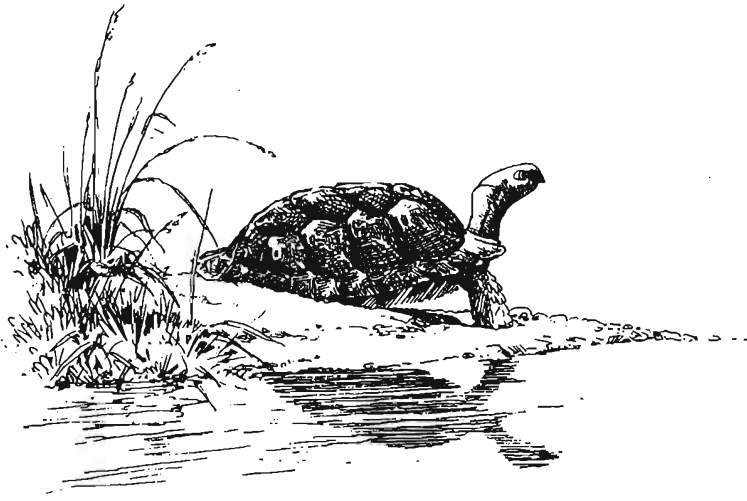
**REPRODUCTION:** Spotted turtles mature at about 7 years of age. Mating occurs during the months of March to May and generally takes place in the water. Copulation follows what is often a long and frantic chase of the female by the male. Nesting occurs in June, with from two to eight eggs laid in sunny, well-drained soil. The hatchlings emerge in August or September, but may overwinter in the nest. In Maine, where climate is probably a major limiting factor in spotted turtle abundance, many young turtles may freeze to death in the nest.

**DIET:** The spotted turtle is omnivorous, with a varied diet ranging from aquatic vegetation to larval amphibians, slugs, snails, insects, and worms, all of which are consumed only while the turtle is submerged in water.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** The spotted turtle is highly prized by the pet trade where they regularly command prices as high as \$400 in Japan and Europe. Illicit commercial exploitation of the species is depleting populations in many parts of their range and may be contributing to the demise of already declining populations in New England. As a Threatened species, Maine spotted turtles are protected, and collection for commercial or personal use is strictly forbidden. Development and habitat fragmentation is likely the greatest threat to Maine's population. The great increase in residential development in recent decades in York and Cumberland counties has contributed to the construction of many new roads, altering of wetlands, and destruction of upland habitats. Skunks, raccoons, and foxes, all efficient predators of spotted turtle nests, have undoubtedly increased as a result of suburbanization. J. Haskins regularly found spotted turtles crushed on roads in York County, a source of mortality that likely takes a heavy toll on egg-laying females. Roadsides, sand pits, and excavation for yards and foundations make ideal nesting areas for spotted turtles. However, concentrating nesting in these areas becomes a trap when predators learn to frequent these habitats during the nesting season.

Conservation of spotted turtles likely depends first on locating viable populations and obtaining a better idea of the species' habitat needs, population dynamics, and natural history. Protecting wetlands, upland corridors between wetlands, and potential nesting areas will be vital to the continued existence of one of Maine's most charming reptiles.

John Glowa, South China, Maine



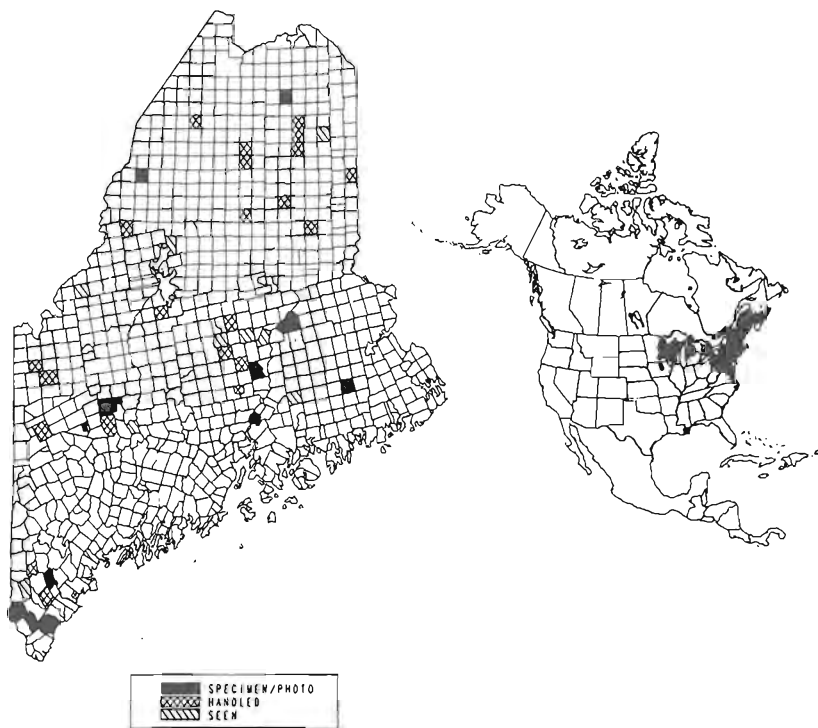
Mark McCollough

## WOOD TURTLE

*Clemmys insculpta*

Admittedly, you may never actually hear a male wood turtle whistling from a tree branch to a female passing below, but conceivably it is possible. The wood turtle is not only one of the most terrestrial of North American turtles, but it is apparently somewhat arboreal, too. Most people would react to the idea of a climbing turtle with outright disbelief, but wood turtles are reported to be “accomplished climbers” and even have been seen climbing a chain link fence (Ernst and Barbour 1972). Also at odds with our perception of a turtle, this species is known to be vocal, emitting a noise resembling a whistling tea kettle during courtship.

**DESCRIPTION:** Wood turtles should not be mistaken for any other turtle in Maine because the carapace, 12.5–23 cm in length (5–9”), is low and broad with the individual scutes being highly sculpted, hence the scientific name *insculpta*. Each scute is roughly pyramidal in shape with concentric ridges and grooves. The only other Maine turtle with a sculpted shell is the snapper, but it has only three low keels; the snapping turtle also has a much smaller plastron than the wood turtle. Both the wood turtle and the snapper have long tails, but the wood turtle’s tail is smooth dorsally and the snapper’s is saw-toothed dorsally. Wood turtles show red or orange color on the neck and



forelegs. The plastron is yellow with irregular dark blotches along the external edges.

Males can be distinguished from females by their longer, thicker tail, a concave plastron with a deeply notched rear margin, and prominent scales on the front of the forelimbs. Young are a gray brown with no red or orange color, the shell is keelless, and the tail is as long as the carapace.

**DISTRIBUTION AND STATUS:** The few records of the wood turtle in Maine indicate a statewide distribution. They have been found in northern Maine, the western mountains, and southern Maine. But the paucity of reported sites leaves questions about regional variations in distribution. The low number of records most likely reflects a low population of the species in Maine. It is listed by the Maine Department of Inland Fisheries and Wildlife as an Indeterminate species, meaning more information must be gathered to determine its conservation status. DeGraaf and Rudis (1983) consider it uncommon to rare in New England as a whole, declining in numbers from the past when it was considered common.

**HABITAT:** Although most authors agree that this turtle may be found far from water at times, its preferred habitat is riparian areas. Slower moving streams are favored, with sandy bottoms an important requisite. Wooded or

heavily vegetated stream banks are of special importance, and heavy disturbances or losses of these riparian areas are probably an important reason for the decline in the abundance of the wood turtle. The stream and riparian areas provide for several special requirements of this animal. The bottoms and muddy banks provide hibernating sites for overwintering turtles, and sandy or gravelly stream banks are used for building a nest and laying eggs. Sandy, gravelly places away from water may also be used at times. Banks and mid-stream logs and rocks are often used as sunning sites.

**REPRODUCTION:** Wood turtles become sexually active in the spring when the water temperature reaches 15°C (59°F) (DeGraaf and Rudis 1983). In Maine, this would normally be late spring, but emergence from hibernation in Maine has not been reported. In areas to the south of Maine, they are known to appear in March.

Wood turtles appear to have a courtship ritual which may involve a dance of sorts. This dance has been observed for several hours prior to actual mating, which takes place in the water. The dance involves the two partners approaching each other slowly with necks extended and their heads up. When they are close to each other, they lower their heads and swing them from side to side (Carr 1952).

After mating, the female will lay her eggs in the sites described in the Habitat section. The clutch may be from 4 to 12, but 7 to 9 is average. Wood turtles lay only one clutch per year. The eggs are white, smooth, and elliptical (4 cm x 2.6 cm). If the nest is not disturbed by a predator, the eggs will hatch in late summer or early fall. Incubation is reported as 77 days (Ernst and Barbour 1972). Late hatchlings have been known to overwinter in the nest. Young turtles have been observed rarely, and thus little is known about their habits and possible differences from adults. Adult turtles are apparently very long lived and may be seen for years even though population recruitment is zero.

**DIET:** The wood turtle is an omnivore. A wide variety of plant material from algae and grasses to berries have been found in stomachs. Animal matter includes insects, fish, earthworms, tadpoles, and carrion from many kinds of animals. Food is unlikely to be a limiting factor.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Unfortunately, the wood turtle's past popularity as a pet may have contributed to local population declines. Ernst and Barbour (1972) reported on Tinklepaugh's experiment of running a wood turtle through a maze and finding its learning ability to be equal to that of a rat. This turtle may have an intelligence and environmental awareness well above that of other herps. Although the wood turtle is considered edible, it is apparently seldom marketed (Ernst and Barbour 1972). The wood turtle is not tolerant of pollution in its environments (DeGraaf and Rudis 1983). This, along with loss of riparian habitats,

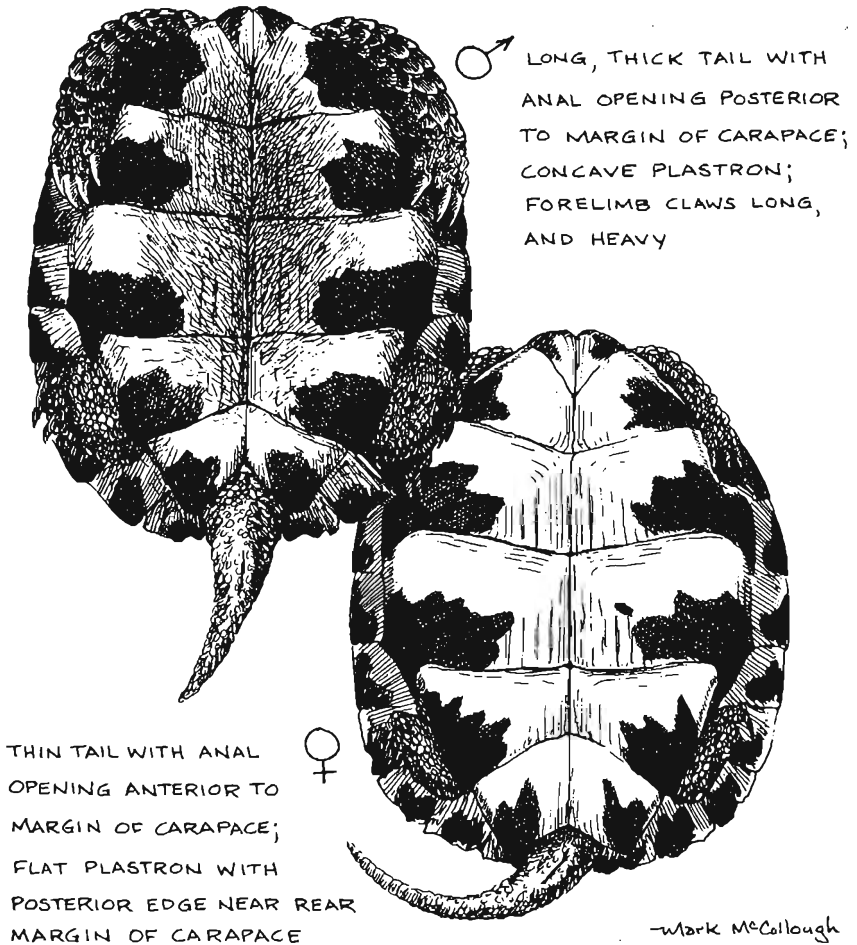


## Wood Turtle

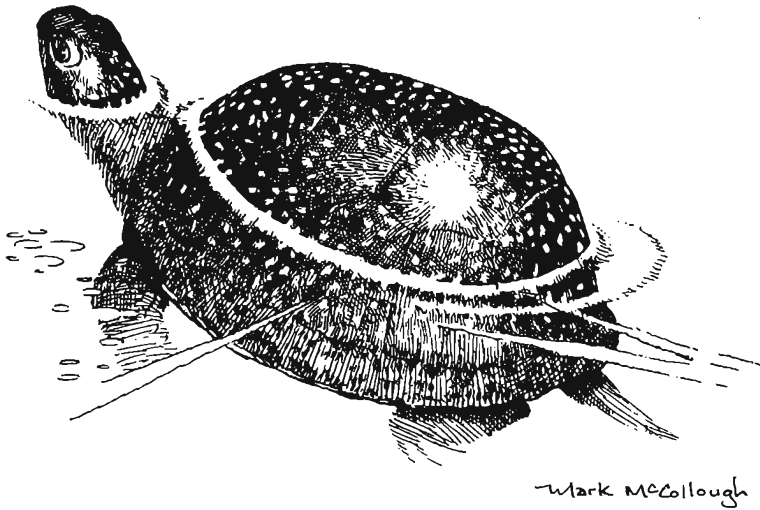
would further stress a depleted population and help explain their increasing scarcity.

Various mammals may consume the eggs and young on land, and fish and other aquatic vertebrates are capable of taking young in the water. Adult turtles, however, are probably very resistant to most predatory attacks. Their reported land speed of .3 kph (.2 mph) is hardly representative of an animal that flees its enemies, and no serious predators to adults are known. Wood turtles are reported to be long lived in the wild, with 58 years mentioned for one in captivity.

Peter A. Cross, Maine Department of Inland Fisheries and Wildlife,  
Farmington



*Sexual characteristics of wood turtles. These same characteristics can be observed in many of Maine's freshwater turtles.*



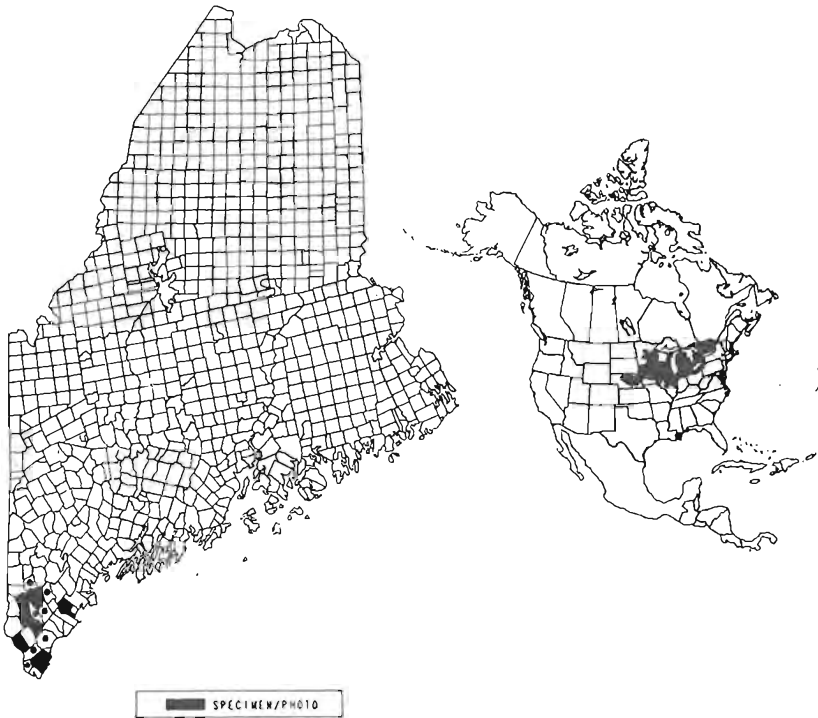
## BLANDING'S TURTLE

*Emydoidea blandingii*

This timid and attractive chelonian is sometimes referred to as a semi-box turtle because of the hinge across its plastron. Its shy disposition and reclusive habit of frequenting inaccessible marshy wetlands reinforce the general impression that it is rare in Maine. The fact is about the only time these bashful reptiles are seen is when the females leave their swampy haunts in June to search for a suitable nesting site on land. These terrestrial jaunts sometimes bring the turtles onto roadways where curious (we hope) motorists stop, pick them up, and then ponder what strange kind of turtle they have found. There simply aren't many people in Maine who are familiar with these helmet-shaped hermits. Careful reconnaissance and trapping have uncovered Blanding's turtles in several York County locations since 1980, and it seems that some of these sites have viable, reproducing populations. Most Maine records, however, represent solitary individuals, and the species is usually scarce wherever it is found. Herpetologists recognize the unusually long neck of the Blanding's turtle as an adaptation for breathing in shallow water. By extending the neck, they can reach the surface from depths other species would find impossible, and in so doing probably conserve the energy required to continually swim up for air. Their snorkeling talent presumably makes them less noticeable to predators as well.

**DESCRIPTION:** The adult Blanding's turtle is a medium-sized animal averaging roughly 18–23 cm (7.1–9.1") in carapace length (CL) and 18–22 cm (7.1–8.7") in plastron length (PL) (Graham and Doyle 1979). Adults found in Maine during 1990 and 1991 ranged in CL from 17.1–22.9 cm and in PL from 16.4–21 cm (Haskins unpubl. notes). The smooth, elongate, helmet-shaped carapace varies from brown to black in ground color and is speckled with light tan vermiculations, streaks, and flecks. The best field character for identification is the conspicuous unmarked yellow chin and throat. The upper jaw is terminally notched and the plastron is transversely hinged between the pectoral and abdominal scutes. The expansive plastron and flexible hinge permit this turtle to close up nearly as well as a box turtle. In pattern and coloration the plastron is similar to that of a wood turtle or a spotted turtle, being ivory yellow with large, black blotches marking the posterolateral portion of each scute. Hatchlings from Massachusetts (Graham unpubl. notes) average about 3 cm in CL (1.2") and about 2.8 cm in PL (1.1"). They have an unmarked, plain brown carapace and dark brown or black plastral scutes sometimes edged with yellow. After successive years of growth, an ivory portion is added to each plastral plate (Graham, unpubl. notes). The Blanding's turtle only superficially resembles the spotted turtle and grows considerably larger. It is profusely covered with light streaks and vermiculations, not the relatively few prominent yellow dots that typify the spotted turtle. Female Blanding's turtles usually have a plastron that is slightly longer than the carapace, while in males the plastron is shorter. Other useful traits to distinguish the sexes include a greater shell height in females and a wider carapace in males (Graham and Doyle 1979).

**DISTRIBUTION AND STATUS:** According to McCoy (1973), the major population center of the Blanding's turtle in North America lies in the Midwest. In addition, disjunct population centers occur in eastern and northern New York, Nova Scotia, and eastern New England (eastern Massachusetts, southeastern New Hampshire, and southern Maine). The occurrence of the Blanding's turtle in Maine was first documented by Packard (1960) who reported a specimen from Waterboro and another from Mousam Lake in Acton. Recent studies indicate a more widespread presence of *Emydoidea* in York County than previously supposed (Graham and Forsberg 1986; Haskins unpubl. data), and the possibility of its residence in Cumberland and Oxford counties must not be overlooked. French (1986) reported Blanding's turtle shell fragments from an Indian site dated at least 500 years BP on Hog Island, Muscongus Bay, Lincoln County, and Coman (1981) reported a specimen found in the 1950s on Mount Desert Island, although this animal was thought to have been introduced. The hiatus between Nova Scotia and southern Maine suggests that this turtle may once have survived in the freshwater marshes of eastern coastal Maine. The cool, foggy climate of this region makes its presence there now an unlikely possibility. Because of their low population and scattered distribution, Blanding's turtles are listed as Threatened in Maine.



**HABITAT:** Blanding's turtles are primarily aquatic, and in Maine they frequent marshes, shrub swamps, slow-moving rivers and streams, and even farm ponds. Shallow, dark, heavily vegetated waters are preferred. In riverine locations, they select the slow-moving waters characteristic of oxbow marshes. Vernal pools are extremely important feeding areas in the spring and summer. Radio-tagged turtles in Maine traveled nearly a kilometer between wetlands and utilized a variety of wetland types during the summer (Haskins unpubl. data). Although habitat requirements of the young are not clear, it is possible that they spend a portion of their time in the damp, peripheral environs of the marsh. Terrestrial nesting habitat is a must for this species and well-drained settings, frequently those under agricultural use, are often sought out as much as a kilometer from water (Linck et al. 1989).

**REPRODUCTION:** Blanding's turtles probably reach maturity at 12–15 years of age (Graham and Doyle 1977; Congdon et al. 1983). Courtship and mating have been observed in Maine from May to July, and Ernst and Barbour (1972) noted that copulation has been seen in every month from March to November (most often from March to May). The female lays a clutch of 12–13 eggs in Maine (two females reported by Graham and Forsberg 1986). Nesting takes place on land during about two weeks in mid-June.

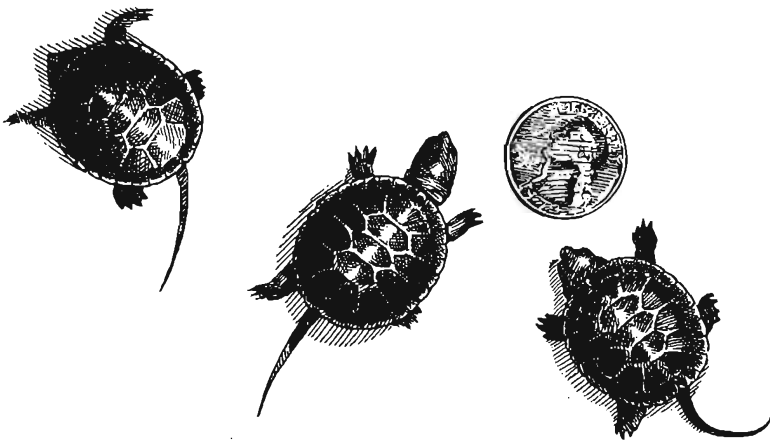
## *Blanding's Turtle*

Nest sites include loam, sand, and even gravelly substrates. Plowed farmlands are favored nesting places in Massachusetts, where hatchlings may emerge from nests as early as 20 August (Graham unpubl. data). Apparently not all females produce eggs every year (Congdon et al. 1983).

**DIET:** Blanding's turtles are reported to feed on land as well as in the water. Their aquatic menu includes larval amphibians, crustaceans, insects, molluscs, plants, and fishes, while their terrestrial diet contains vegetation, berries, slugs, insect larvae, and earthworms. The scat from one Maine female contained many tiny aquatic snail shells (Graham unpubl. data).

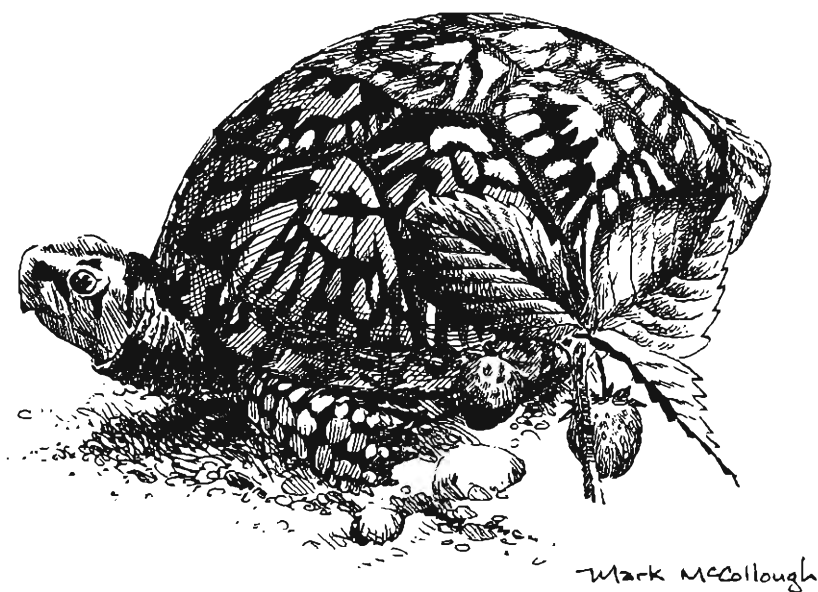
**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Being extremely docile by nature, Blanding's turtles will seldom bite even if poked on the snout. They are very timid and sometimes attempt to flee when approached in the water. They are powerful and swift swimmers, but occasionally, in dark water, or water covered with a carpet of duckweed, they will pull in and sit quietly on the bottom until all sign of danger has passed. Although their nests are frequently destroyed by mammalian predators, and some adults are killed annually crossing roadways, a far greater threat to the future of the Blanding's turtle lies in the alarming reduction of available nesting and marshland habitat. Marshland manipulation (including both drainage and impoundment) has certainly reduced available habitat, and the alarming trend of decreased agricultural land use could discourage population expansion through reduction in available preferred nesting substrate. Conserving all wetlands, upland corridors between wetlands, and nesting habitat, together with strict water pollution control, will be vital to the survival and increase of the Blanding's turtle in Maine.

Terry E. Graham, Worcester State College, Worcester, Massachusetts



Mark McCollough

*Blanding's turtle hatchlings.*



## EASTERN BOX TURTLE

*Terrapene carolina*

The box turtle is an innocuous and relatively tame species that is uncommon in most of New England and has probably never been abundant (Babcock 1919). Because this turtle is easily captured and tamed, it is often kept as a pet and moved to new locales. Thus captive turtles are encountered far from their native range, making identification of small, isolated populations difficult (Smith 1961). Genetic contamination can occur when captive turtles are released in the vicinity of natural populations. This issue is very relevant to Maine, where several box turtles have been reported in recent years, which could have been released pets. It may be possible to distinguish wild box turtles because when captured they characteristically seal themselves tightly within their shells using the hinge on their plastron. Within a few weeks, they become tame and no longer use this defense mechanism.

**DESCRIPTION:** Adult box turtles have a distinctive, dome-shaped carapace and a fully hinged plastron which completely fills the aperture of the carapace. The carapace ground color is brown to black with a highly varied yellow or orange pattern in each carapace shield. A slight mid-dorsal keel is present. The plastron is variably patterned light and dark—almost a mottled pattern of dark brown/black or tan/yellow. The head, neck, and legs are uniformly dark with orange or yellow mottling. Adult carapace length

ranges from 10 to 20 cm (3.9 to 7.9"). The upper mandible is strongly hooked at the tip, and the hind feet have 4 toes. The other Maine turtle most similar to the box turtle is the Blanding's turtle. The mottled markings of the box turtle are quite different from the Blanding's flecks; also, the box turtle lacks a notch in the upper mandible and has a shorter tail. Male box turtles can be distinguished by a concave plastron and red orange eyes. Females have a flat plastron and brownish eyes. In males, the anus is more posteriorly positioned on the tail, which is proportionately longer than the female's tail. Males have stouter hind legs with thicker and decurved claws. Males also have a higher and wider carapace than females. The box turtle may have the greatest longevity of any terrestrial vertebrate, with a New England individual reaching an age in excess of 120 years.

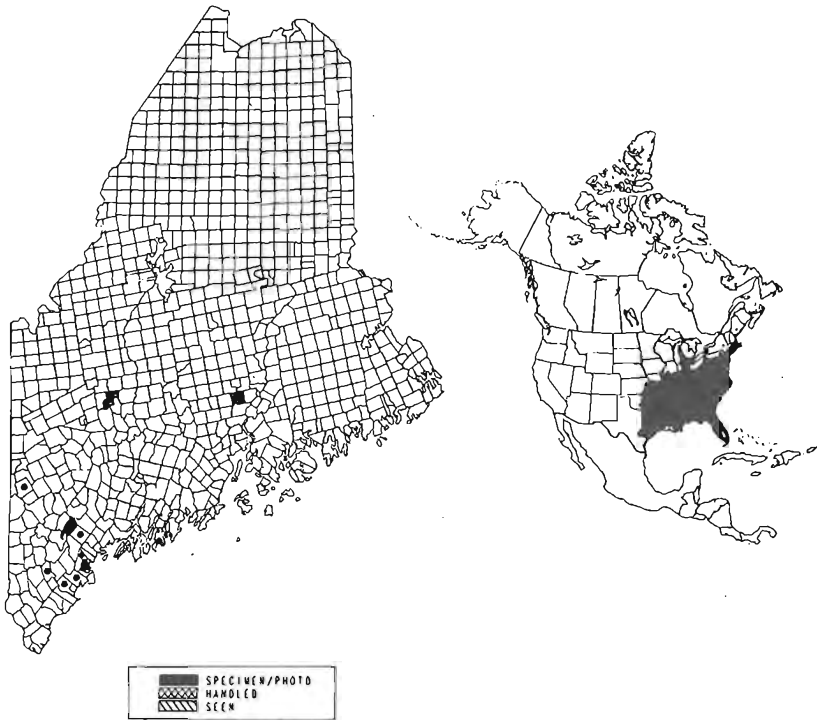
Hatchling box turtles are generally a uniform dark color with yellow along the mid-dorsal keel, carapace border, and lower mandible. A black blotch covers most of the plastron. The carapace, which is flat and circular in shape, averages 3.3 cm (1.2"). The plastral hinge is poorly developed and nonfunctional. Post-hatchling juveniles continue to exhibit a distinct keel even though the carapace becomes more adult-like in shape and the plastral hinge becomes functional (Smith 1961).

**TAXONOMIC STATUS:** *Terrapene carolina carolina* is the subspecific identification of Maine's box turtles.

**DISTRIBUTION AND STATUS:** Box turtles are likely Maine's rarest reptile. They probably have never been common in Maine, and their natural range may include only the southwestern part of the state in York and Cumberland counties. However, MARAP records include specimens collected or photographed as far north and east as New Vineyard, Franklin County, and Herman, Penobscot County. The New Vineyard turtle was suspected to be a released pet, but the Herman record was followed three years later by a sighting of two turtles. If there is a natural population in Hermon, not just a few escapees, it would extend the range of the species over 150 kilometers (95 miles).

In Maine, where the box turtle is at the northern extreme of its range, the species has been classified as Endangered (Swartz 1987). The species is listed as a species of concern to conservationists in Massachusetts, New Hampshire, and New York. The bulk of the box turtle population in Massachusetts occurs in the southeastern section of the Bay State, just west of Cape Cod, and is generally uncommon, although in localized pockets it is common.

**HABITAT:** The box turtle is one of the most terrestrial of the Testudines. It is a woodland species which prefers open, lightly stocked woods, but has been found in both dry and moist woodlands, brushy fields, woodland edges, and bogs. Box turtles are known to enter water or mud during hot weather,



and are often found near streams, ponds, and other low, wet areas. Box turtle home ranges average about 100–225 meters (100–750') in diameter. Some individuals are transient and do not establish home ranges (Keister et al. 1982). Box turtles generally enter hibernation at the time of the first killing frost and burrow under loose soil, detritus, or mammal burrows. Cold temperatures, particularly depth of soil freezing, may be the most limiting factor in Maine (Ernst and Barbour 1972).

**REPRODUCTION:** Box turtles mate throughout most of their active period, usually April to October, with most matings occurring in spring. Courtship begins with the male circling the female and biting at her shell, head, and legs, before mounting. At intromission, the male rocks backward to a near vertical position to bring his vent into contact with the female's vent. Males have been known to die after mating by falling backward onto their carapace from which position they are unable to upright themselves. Females may remain fertile as long as 2–4 years after mating.

The female excavates a nest in loose, well-drained soil, usually in an open area in close proximity to previous years' nests (Stickel 1989). Nesting activity often extends female home ranges by 400–700 m (1300–2300'). Egg laying occurs in June and July during the late afternoon-early evening and continues until 3–8 elliptical, white, thin, and flexible-shelled eggs are



deposited (Ernst and Barbour 1972). The female covers the eggs with soil, and they remain in the nest until hatchlings emerge about 87–89 days after laying, usually in September (Carr 1952). Young box turtles either emerge from the nest for a short time before hibernating or overwinter in the natal nest.

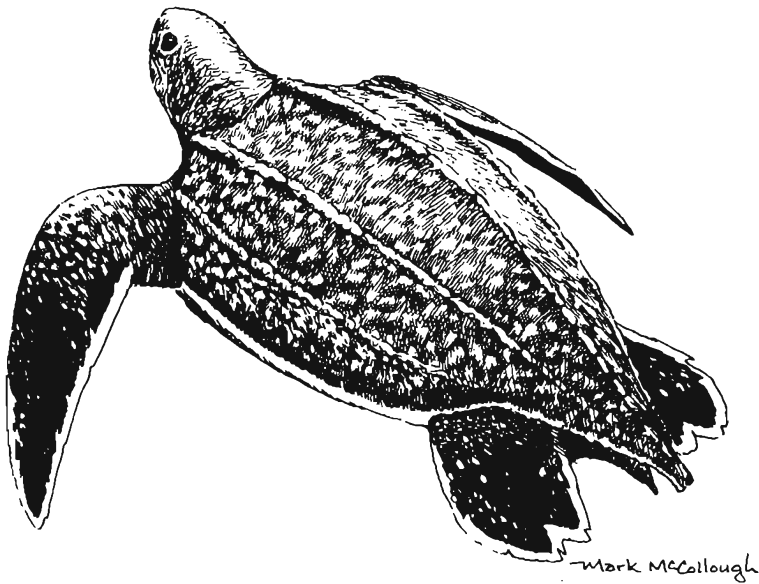
**DIET:** Hatchling box turtles do not feed until emerging in the spring, when they forage for earthworms, slugs, snails, insect larvae, spiders and millipedes, and small amounts of plant material. Adults feed primarily on fruits, fungi, leaves, stems, and occasionally carrion and small invertebrates. Blackberries, raspberries, and similar fruits are favorite box turtle food. Box turtles will also feed on tomatoes, cucumbers, lettuce, and other garden produce.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Box turtles are harmless creatures. As mentioned above, they may on occasion damage gardens, but that is the extent of box turtle depredations against humans. People have been known to become ill after eating the flesh from turtles that have been feeding on mushrooms. Humans, on the other hand, have had a profound effect on box turtles. Slow-moving turtles are vulnerable on roads and railroads, especially in the spring after emergence from hibernation. Pesticides have not, to our present knowledge, been a factor in decline, though there may be some indirect effects. Still, Stickel (1951) found no differences in numbers of box turtles in DDT-sprayed and unsprayed areas after 5 successive years of treatment.

Predators such as coyotes, red and gray foxes, raccoons, and striped skunks dig up turtle nests and consume eggs and hatchlings. These same predators may occasionally eat an adult, but the box turtle's protective shell is an effective defense against most predators other than humans.

Box turtle populations are believed to be declining in New England (DeGraaf and Rudis 1986). Long-term studies of box turtle populations in Maryland, Indiana, and Missouri have documented 40–50% declines in recent decades. The greatest threat to Maine box turtles is fragmentation and destruction of their habitat in southern Maine. It is unknown whether viable populations of box turtles still exist in Maine. Perhaps their presence in our state can be ensured by protection of the few remaining contiguous tracts of forestland in southern Maine.

Roger D. Applegate, Maine Department of Inland Fisheries and Wildlife,  
Bangor



## MARINE TURTLES OF THE GULF OF MAINE

Five species of marine turtles inhabit the western North Atlantic, and three of these species, the loggerhead, Atlantic or Kemp's ridley, and leatherback, have been reported along the Maine coast or in the Gulf of Maine. All three turtles are currently listed as federally endangered or threatened species, as are most marine turtles. The green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) have not been reported from the state of Maine, but could occur here.

### LEATHERBACK TURTLE

*Dermochelys coriacea*

**DESCRIPTION:** The world's largest living turtle, adults are 118–244 cm (46.5–96") in carapace length and weigh from 300–700 kg (700–1600 lbs) (Ernst and Barbour 1972). This turtle has a smooth shell covered with skin, lacking horny scutes. The dark brown to black carapace is elongated and triangular and smooth except for 7 prominent longitudinal keels that divide the carapace. The black limbs are paddlelike and clawless, sometimes with white blotches.

**DISTRIBUTION AND STATUS:** The Atlantic leatherback (*D. c. coriacea*) ranges through the tropical and temperate waters of the Atlantic Ocean,

Gulf of Mexico, and Caribbean Sea, from Newfoundland and Labrador to Norway and the British Isles, and south to Argentina and the Cape of Good Hope (Ernst and Barbour 1972, Threlfall 1978, Willgoos 1957). Sightings of leatherbacks along the Maine coast and in the Gulf of Maine have been compiled by Babcock (1919, 1938, 1939, 1945), Bleakney (1955, 1965, 1967), Scattergood and Packard (1960), Shoop et. al. (1981), and Squires (1954); single sightings have been reported by Moulton (1963), Ray and Coates (1958), and Whitely (1938). Aerial surveys in the Gulf of Maine by Thompson in 1984 document densities of 7–8 individuals per 10,000 km<sup>2</sup> during summer and fall, with leatherbacks absent or very sparse in winter and spring (Committee on Sea Turtle Conservation 1990).

Nesting occurs on beaches as far north as North Carolina (Lazell 1980). Major nesting concentrations occur along the Guiana coast (Pritchard 1976). The Atlantic leatherback is listed federally as an Endangered species, and the state of Maine has reflected that designation by declaring it a state Endangered species.

**HABITAT:** Leatherbacks are pelagic except when nesting on tropical and subtropical beaches. They seem to follow jellyfish migratory patterns, seasonally moving north along the Atlantic coast into the Gulf of Maine and Georges and Browns banks on the Gulf Stream by August, then inshore and back south in autumn through the bays and sounds of New England (Lazell 1980). They winter in the Gulf of Mexico and along the Florida coast, again feeding on jellyfish. The Gulf of Maine provides a somewhat sheltered location for the growth and development of these medusans in large numbers, and as such provides important feeding grounds for leatherbacks.

Bleakney (1965) noted that leatherbacks were not benumbed by cool sea temperatures of 13–18°C (55–65°F) in the Gulf of Maine. Leatherbacks can maintain warm temperatures in cold water (Frair et al. 1972). Greer et al. (1973) described a counter-current circulatory system that permits homeothermy in leatherbacks. Active leatherbacks have been seen off the Labrador coast where water temperatures “could not have exceeded 42.8°F [6°C]” (Threlfall 1978). Females may not migrate north as far as males (Rhodin and Shoelkopf 1982; Lazell 1980).

**REPRODUCTION:** Females nest every second or third year (Pritchard 1971). Clutch size is 50–170 eggs; a percentage of the eggs are yolkless (Pritchard 1971). Incubation periods for leatherbacks range 53–74 days (Ernst and Barbour 1972).

**DIET:** Leatherbacks feed preferentially upon the Arctic jellyfish, *Cyanea capillata*, their parasites, and symbionts (Bleakney 1965).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Humans, monitor lizards, and dogs are known nest predators (Ernst and Barbour 1972). Hatchlings have a host of mammalian and avian predators as they

head for the sea. Leatherback turtle oil has been a component in some cosmetics (Cook 1984; Ernst and Barbour 1972). Adult leatherback meat is consumed by humans in part of its range. Ingestion of plastics could be an important mortality factor (Committee on Sea Turtle Conservation 1990).

## LOGGERHEAD TURTLE

### *Caretta caretta*

**DESCRIPTION:** Probably the largest living hard-shelled turtles, loggerheads are only exceeded in carapace length and weight by the leatherback. Adults are 71–213 cm (28–83.9") in carapace length and usually weigh about 140 kg (300 lbs), although individuals up to 500 kg (1200 lbs) have been reported (Ernst and Barbour 1972). The loggerhead tends to have a reddish brown carapace with scutes often bordered with yellow.

**DISTRIBUTION AND STATUS:** The Atlantic loggerhead (*C. c. caretta*) ranges through the North and South Atlantic, occasionally entering the Mediterranean Sea, from Newfoundland to the British Isles, and south to Argentina, the Canary Islands, and the western coast of tropical Africa (Ernst and Barbour 1972). Sightings of loggerheads along the Maine coast and in the Gulf of Maine are much fewer than for leatherbacks and have been compiled by Bleakney (1955, 1965, 1967), Carr et al. (1982), Lazell (1980), Scattergood and Packard (1960), and Squires (1954). Aerial surveys in the Gulf of Maine by Thompson in 1984 document densities of 1–4 individuals per 10,000 km<sup>2</sup> in summer, with loggerheads absent in winter (Committee on Sea Turtle Conservation 1990).

Loggerhead turtles formerly nested on Atlantic beaches from Virginia to the Gulf coast; today the breeding range is from Cape Lookout, North Carolina, southward (Dodd 1988, Ernst and Barbour 1972). Nesting also occurs on open beaches or along narrow bays in the Caribbean. They are listed federally as a Threatened species and listed by the state of Maine as a Threatened species.

**HABITAT:** Loggerheads wander widely through their range, using many inshore habitats as well as habitats far out in the warm Gulf Stream waters of Georges Bank (Cook 1984).

**REPRODUCTION:** Caldwell (1962) reports females return to nest every 2 to 3 years. Nests are dug above the high-tide mark. Clutch size is 64–341 eggs (Ernst and Barbour 1972), and incubation period ranges up to 68 days (Ernst and Barbour 1972).

**DIET:** Loggerheads are omnivorous and feed in a variety of sites such as coral reefs, rocky places, and old wrecks (Ernst and Barbour 1972). Loggerheads consume sponges, jellyfish, shellfish, squid, shrimp, amphipods,

barnacles, sea urchins, tunicates, and fish, as well as various seaweeds, turtle grass (*Zostera* and *Thalassia*) and *Sargassum* (Ernst and Barbour 1972). Bleakney (1967) reports indiscriminate feeding on faunal elements associated with *Sargassum* species.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** The loggerhead is an important source of meat and eggs in many parts of its range. Raccoon predation on nests and eggs can be significant (Committee on Sea Turtle Conservation 1990). Nesting on Atlantic beaches has been threatened by recreational development, beachfront condominium construction, and industrial siting.

## ATLANTIC RIDLEY TURTLE

### *Lepidochelys kempii*

**DESCRIPTION:** The ridley is a small (51–71 cm) sea turtle with a heart-shaped carapace. The carapace is grayish green as are the paddlelike limbs, which give the ridley a characteristically “ghostlike appearance” (Ernst and Barbour 1972). Ridleys were commonly mistaken for loggerheads by earlier workers, as noted by Scattergood and Packard (1960) and Ernst and Barbour (1972). Loggerheads tend to be larger, have reddish brown carapaces and three inframarginal scutes at the bridge; ridleys tend to be smaller, have grayish green carapaces and four infra-marginal scutes at the bridge.

**DISTRIBUTION AND STATUS:** The Atlantic ridley ranges in the western Atlantic from Nova Scotia (Bleakney 1955), Newfoundland (Cook 1984), and the Gulf of Maine, south to Bermuda and west through the Gulf of Mexico to Mexico. Ridleys also cross the Atlantic on the Gulf Stream and are seen in England, Ireland, France, the Azores, and occasionally in the Mediterranean Sea (Ernst and Barbour 1972). In the late summer through fall, many ridleys are seen along the Massachusetts coast (Lazell 1980). Ridleys have been removed from floating fish traps at Small Point, Sagadahoc County (Scattergood and Packard 1960) and reported in the Gulf of Maine by (Bleakney 1955), Lazell (1980), and Shoop et al. (1981). Nesting occurs on the beaches of the Gulf of Mexico between Corpus Christi, Texas, and Veracruz, Mexico; most activity is concentrated on a single stretch of beach at Rancho Nuevo in the Municipio de Aldana (Chavez et al. 1968a). The ridley is listed as an Endangered species by both federal and state of Maine authorities.

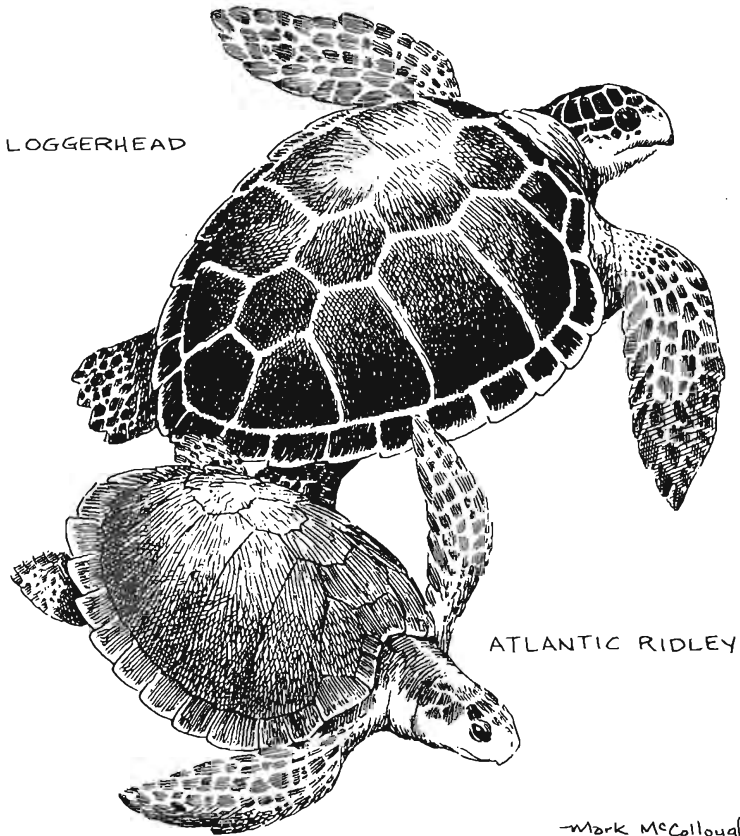
**HABITAT:** Ridleys feed on the bottom frequently (Ernst and Barbour 1972). Ridleys use shallower water for foraging than loggerheads in the summer, foraging for the faster moving crabs on seagrass beds (Committee on Sea Turtle Conservation 1990).

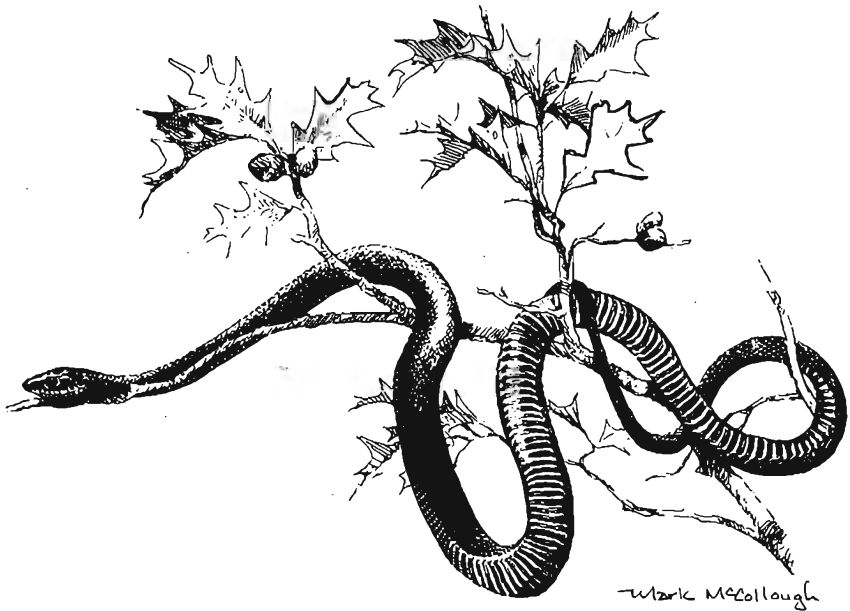
**REPRODUCTION:** Most females come to nest in groups—by the thousands at times (Carr et al. 1963). Nesting activities are diurnal. Clutch size averages 110 (ranging from 54–185 eggs) (Chavez et al. 1968b), and incubation ranges from 50 to 70 days (Chavez et al. 1968b).

**DIET:** Ridleys are predominately carnivorous, feeding on crabs, snails, clams, and some marine plants.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Lazell (1980) comments on the number of injured ridleys recovered from the Massachusetts coast in late fall, perhaps associated with beam trawler activities close to shore.

Mariko Yamasaki, USDA Forest Service, Northeastern Forest Experiment Station, Durham, New Hampshire



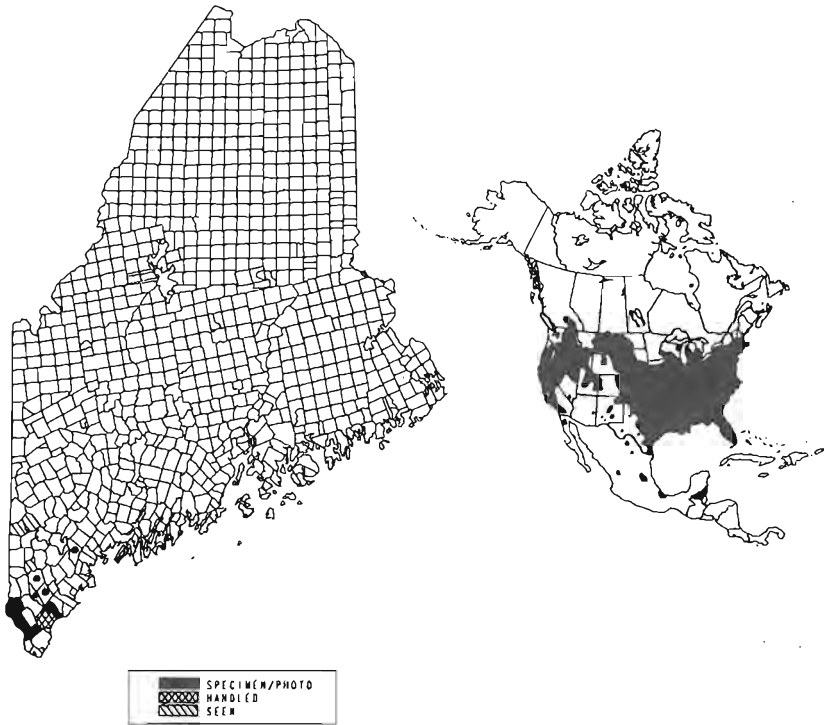


## RACER

*Coluber constrictor*

Maine's largest snake, the black racer, is aptly named. It is lightning fast and difficult to catch, and its beautiful glossy black upper parts are unique among Maine reptiles. Once quite widespread throughout the southern part of the state, racers have declined in recent years, and their range now appears to be restricted to York and southern Oxford counties.

**DESCRIPTION:** Adult black racers are long and slender with a uniformly glossy black dorsum unique among Maine snakes. The chin, neck, and jaw, including the area above the mouth, are white, and the venter is pale to medium gray. Close examination often reveals a thin white line extending from the snout over the eye to the neck. Racers are Maine's longest snakes; adults range from 90–185 cm (36–73"), though recent specimens within the state have not measured over 140 cm (56"). Black racers have glossy smooth scales, 17 dorsal rows (15 at vent), and divided anal plates. Juvenile black racers, 20–33 cm (8–13") at birth, are heavily blotched and can be easily confused with milk snakes and northern water snakes. Milk snakes tend to have brighter red blotches and generally have a distinctive gray "Y" on the head and neck. Like racers, milk snakes have smooth scales, but they possess a single anal plate. Water snakes, usually found in wet habitats, are heavier, with a thicker body and dark blotches that extend completely across the back and sides and a checkered venter. Water snakes have keeled scales



and divided anal plates. Young black racers lose their patterning before they reach 75 cm (30") in length. Dark, unstriped garter snakes, uncommon but widespread in Maine, are frequently misidentified as racers. Garter snakes, however, have keeled scales and a smooth anal plate.

**TAXONOMIC STATUS:** Racers occur across most of the United States, except the southwest, and given this wide distribution it is not surprising that at least 11 subspecies have been described; *C. c. constrictor*, the northern black racer, is the subspecies in Maine.

**DISTRIBUTION AND STATUS:** In the 1930s, black racers were considered common in the vicinity of Cobbosseecontee Lake, Kennebec County (Fowler 1942), but interestingly, the species was not listed by Verrill (1863) for the region around Norway, Oxford County, a region of seemingly appropriate habitat. The species probably had a spotty distribution throughout southern Maine. Black racers have been little reported in recent years, and the only substantiated population of any size occurs in dry scrub forest habitat in Wells and Kennebunk, where they have been reported annually. Additionally, black racers have been recorded from several York County towns and there are unconfirmed reports from Cumberland County and southern Oxford County. The species is listed as Endangered by the Maine Department of Inland Fisheries and Wildlife.



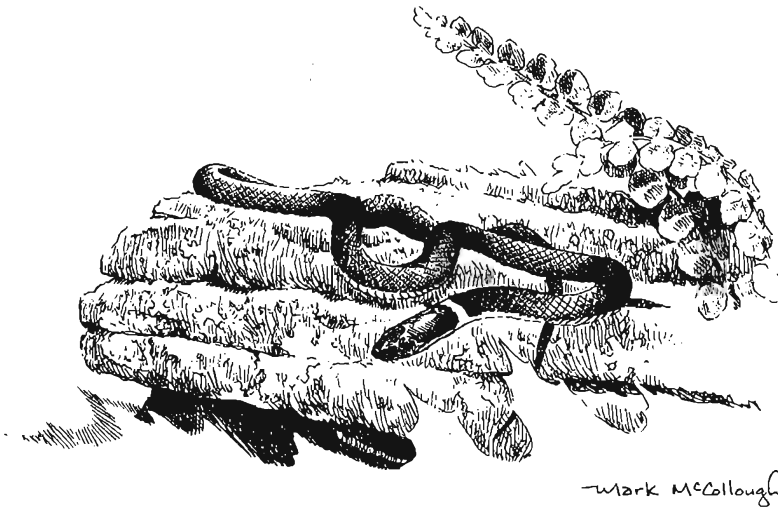
**HABITAT:** Unlike most New England snakes, black racers appear to have a distinct home range and may be territorial (Fitch 1963). They occupy a wide variety of habitats; xeric and mesic forests, both deciduous and coniferous, old brushy pastures, old buildings, and rocky ridges and ledges. In Maine, racers occur in similarly diverse habitats, but seem to favor dry, brushy areas. If pursued, racers often escape by climbing into low branches and bushes (Conant 1975). Racers often den communally, sometimes with other snakes including rattlesnakes. This is an important aspect of their biology (Brown and Parker 1976) and may be a factor limiting their distribution in Maine.

**REPRODUCTION:** Black racers are sexually mature at two or three years and have been reported to form dense, tangled "mating balls" similar to the garter snakes of the northern Plains (Wright and Wright 1957); aggregations involving many individuals have been witnessed in Maine (L.M. Eastman pers. comm.). These "tangles" apparently result from pheromones released by the female that attract many males (Lillywhite 1985). Black racers are unusual in that mating snakes will sometimes drag themselves from the ground, still in intromission, into trees and shrubs; most snakes do not locomote when copulating (Lillywhite 1985). In New England, mating occurs in May to early June. Black racers are oviparous, laying 7–31, usually 16 or 17, leathery eggs (Fitch 1963) with a distinctive "rough granular texture" (Behler and King 1979). The eggs are 2.5–4.8 cm (1–1.8") long and are deposited 5–8 cm (2–3") below the ground in loose soil, litter, sawdust, or hollow logs (Wright and Wright 1957). Females sometimes use communal nests. Young hatch in August and September and are 20–33 cm (8–13") long.

**DIET:** Despite the Latin name *C. constrictor*, the species does not kill by constriction, but bites and holds its prey like most other Maine colubrids. A diurnal hunter, the racer's varied diet includes frogs, toads, small birds and their eggs, small mammals, insects, lizards, and other snakes. Small mammals and insects have been reported to make up 50% of the racer's diet (Surface 1906), though in the Northeast small mammals and snakes (even copperheads on occasion) are the primary prey consumed by this species (Fitch 1963).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Throughout most of their range, black racers have readily accommodated to human presence. Racers are undoubtedly the victims of thoughtless persecution, especially if they den with rattlesnakes, but their extraordinary speed and preference for shrubby areas seems to have helped them persist. During the mating season in early summer, racers are frequently aggressive and sometimes follow and chase humans (Fitch 1963). When encountered in the forest, racers often hold their ground and, if annoyed or approached too closely, will make a rattling sound by vibrating the tip of the tail. They bite and thrash vigorously if captured. Their aggressive dispositions and susceptibility to parasites and infections make racers poor captives.

Peter D. Vickery, Wildlife Department, University of Maine, Orono



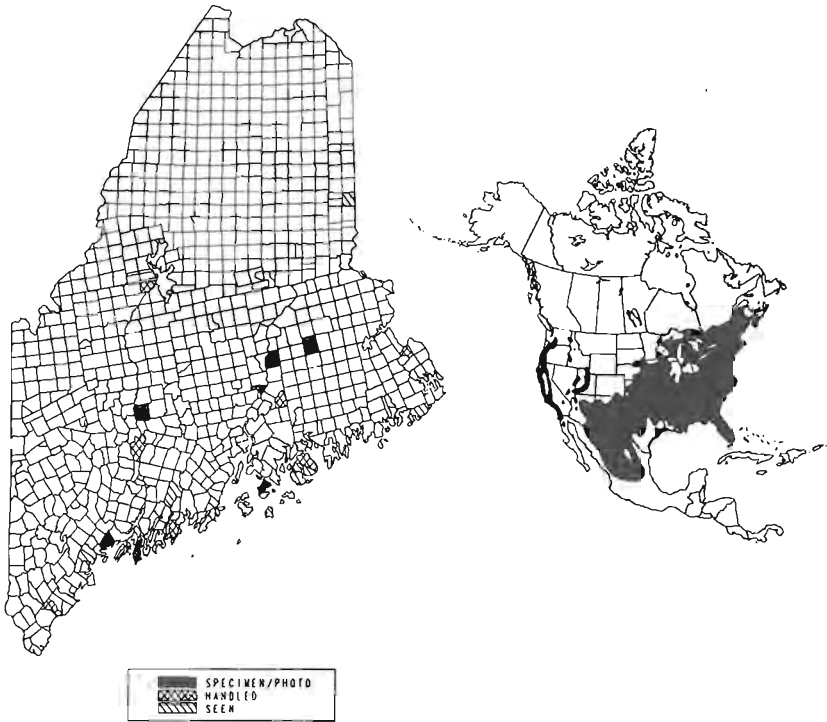
## RINGNECK SNAKE

*Diadophis punctatus*

Beauty can be elusive, so also the ringneck snake. Both beautiful and elusive, that is. Most field guides and descriptions of the ringneck refer to this snake as "common" and then go on to call it "secretive," which means that most of us have never or rarely seen one.

Information on this creature is equally elusive. In reviewing several herpetological journals for information on *Diadophis punctatus*, the author found several years where the journals' indices had no listing for ringneck snakes for the entire year. Other years had a few references to ringnecks as food items in some other creature's diet, or found hibernating with some other snake. Few, if any, studies exist in which the ringneck is the central character. So what does this lack of formal attention really mean? Probably that the ringneck snake is just an ordinary type of snake. Possibly it means that the snake is not abundant enough to study, since meaningful research requires reasonable numbers of subjects. Ringnecks do not pose any danger to people or their possessions, nor are they particularly fascinating in any other way, as evidenced by the lack of myths, legends, or folklore about them. No, the only thing that can be said about the ringneck snake is that it is an attractive, quiet neighbor which attracts little attention.

## Ringneck Snake



**DESCRIPTION:** The ringneck snake takes its name from its distinctive, completely yellow, golden, or orange neck ring. The northern subspecies of ringneck, which occurs in Maine, generally has a belly of uninterrupted yellow from head to tail, although occasionally an individual will have small black dots along the mid-line of the belly. In several other subspecies located to the south and west of Maine, the numbers, size, and arrangement of these black dots are distinctive features. Dorsal color may be slate gray, brown, or black. The scales are smooth and often referred to as satiny in appearance; the anal plate is divided. Ringnecks are generally small snakes averaging 25–35 cm (10–14"). Extreme measurements from other parts of the species' range are from 60–75 cm (24–30").

Both of Maine's other small snakes, the brown snake and the red-bellied snake, can also have some semblance of a neck collar occasionally and may also have a yellowish venter; however, they both have keeled scales.

**TAXONOMIC STATUS:** Maine's ringnecks belong to the subspecies *D. p. edwardsii*, the northern ringneck snake.

**DISTRIBUTION AND STATUS:** Based on MARAP data, the ringneck snake is apparently widespread in Maine, but not necessarily abundant or easily found. Eleven of Maine's 16 counties have reports for ringnecks, although only two counties, Penobscot and Hancock, have more than two

reports. Currently, the majority of reports are for towns along the coast, although the most northerly reports from Sapling Plantation, Somerset County (just west of Moosehead Lake), and Houlton, Aroostook County, are a considerable distance inland. Given the presence of ringneck snakes in neighboring Quebec and New Brunswick, ringnecks are expected to have a statewide distribution. However, they are at the northern limit of their range in these provinces and are not likely to be abundant there or in northern Maine.

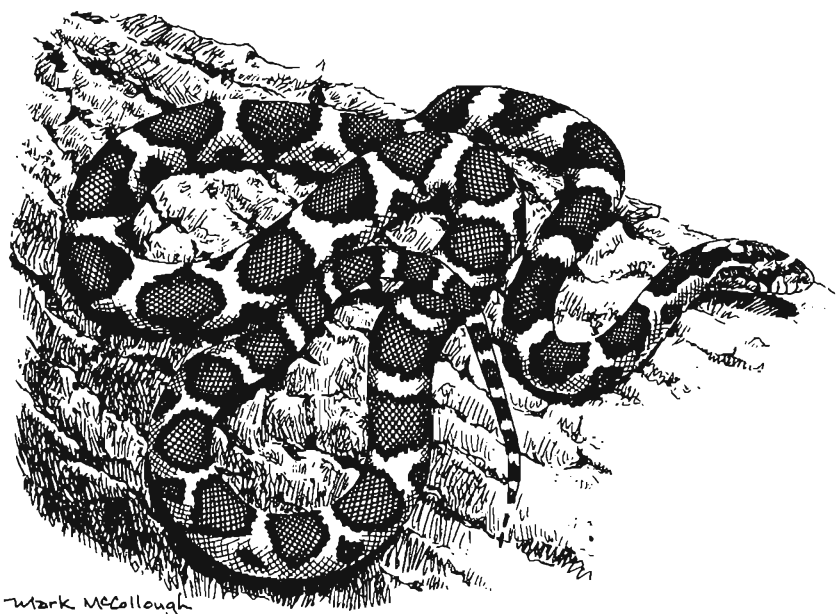
**HABITATS:** The northern ringneck is generally considered a snake of moist woodland habitats. Ringnecks are nocturnal animals and are very rarely found abroad during daylight hours. Because of this, they prefer habitats with an abundance of hiding places such as rock piles, stone walls, old boards, bark piles, and decaying logs. Minton (1944) stated that ringnecks are not true burrowers, but use objects on the ground surface for cover.

**REPRODUCTION:** Breeding takes place soon after emergence in the spring. Ringnecks are oviparous although there are instances of females giving birth to live young. Typical clutch size is 3–4 eggs with as many as 10 reported. Laying occurs in late June through July followed by a 4–6 week incubation period, a relatively short incubation compared to other snake species. Ringnecks commonly have communal nests. Blanchard and Blanchard (1937) reported finding egg shells from the previous year in one communal nest site, indicating reuse of the same site. The white or yellowish eggs measure 2.5–3.3 cm (~1") long. At hatching, young measure 10–15 cm (4–6").

**DIET:** One author (Minton 1944) referred to the ringneck's prey as "almost any small creature they can swallow." This even included small minnows concentrated in small pools of water along a drying stream bed. More typical fare includes salamanders, worms, frogs, small snakes, and insects.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** This small snake is totally innocuous to people. Relatively little is known about its relationships with other animals. Because of its nocturnal and secretive habits, it probably rarely falls prey to raptors and other birds as is the case with many other species of snakes. Perhaps the ringneck's greatest enemies would be larger snakes and mammalian predators such as skunks, which may discover them under objects or in rotting logs.

Barry N. Burgason, Enfield, Maine

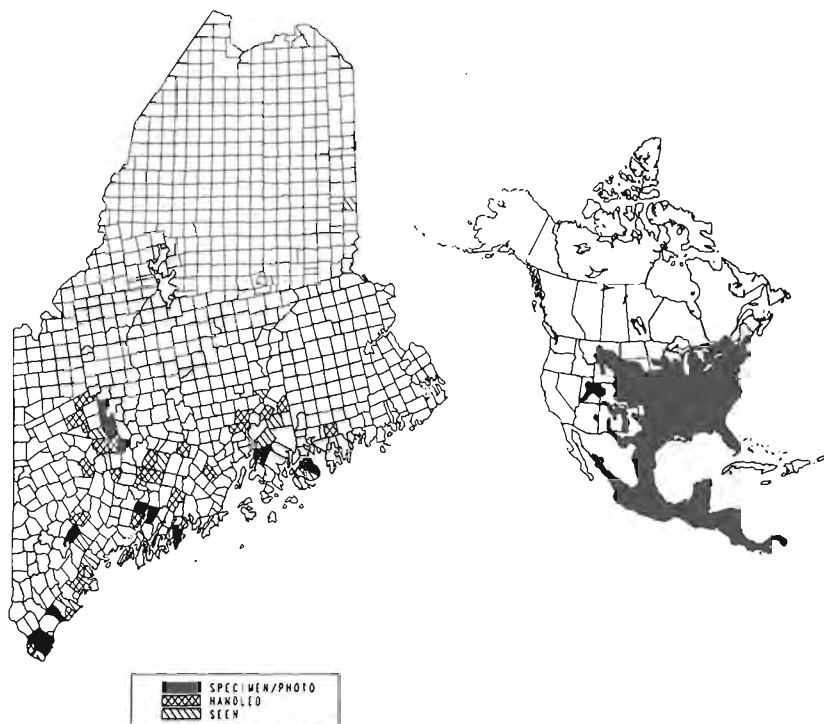


## MILK SNAKE

*Lampropeltis triangulum*

Although the old-wives' tale that told that this snake suckled milk from cows no doubt contributed to its name, the milk snake has no interest in cattle or their milk. The species does, however, enter farm buildings while hunting for rodents. In Maine, it is sometimes confused with the timber rattlesnake, to which there is a remote resemblance, and farther south, milk snakes are mistaken for the venomous copperhead. Despite this confusion, and the inappropriate nickname of "milk adder," this animal is entirely harmless to humans. In fact, because of its appetite for small rodents, this species is considered to be beneficial to farmers.

**DESCRIPTION:** The milk snake is one of Maine's longer snakes, averaging 61–91 cm (24–36"). They are slender, have a light base color of gray to tan, and are strongly marked with brown or reddish brown blotches in 3 to 5 rows, with the mid-dorsal row having the largest blotches. The belly is characterized by an irregular black-on-white checkerboard pattern. Young milk snakes have bright red blotches on a light background. Milk snakes bear a superficial resemblance to rattlesnakes and will even shake their tail in dry leaves to produce a rattling sound. The rattlesnake's large, triangular head, unmarked venter, and rattle-bearing tail distinguish it from milk snakes. The northern water snake is marked with dark bands rather than blotches,



and the background color of the water snake is darker. Water snakes, unlike milk snakes, have keeled scales. The water snake's venter is usually marked by dark half moon shapes, unlike the checkerboard pattern common to the milk snake.

**TAXONOMIC STATUS:** *L. t. triangulum*, the eastern milk snake, is the subspecies in Maine.

**DISTRIBUTION AND STATUS:** Widespread south of the state, the milk snake reaches its northeastern range limit in Maine. It occurs from southern and western Maine east into Hancock County, with one unconfirmed outlier record from Houlton, Aroostook County. As old fields succeed to forests, milk snake populations may be declining in the eastern United States.

**HABITAT:** Typical haunts involve some woody or brushy cover such as mixed farmlands and woods. They have been found in open areas such as bogs, meadows, and prairies as well as pine and hardwood forests. In farm country, they are often found near human dwellings and outbuildings. Optimal habitat in Kansas was considered to be woodland edge, open forest, and short grass, all with a good supply of flat rocks or other hiding cover (Fitch and Fleet 1970). People often find this animal hiding during the day under rocks, logs, boards, rubbish, tar paper, or in rotted stumps or logs.

## *Milk Snake*

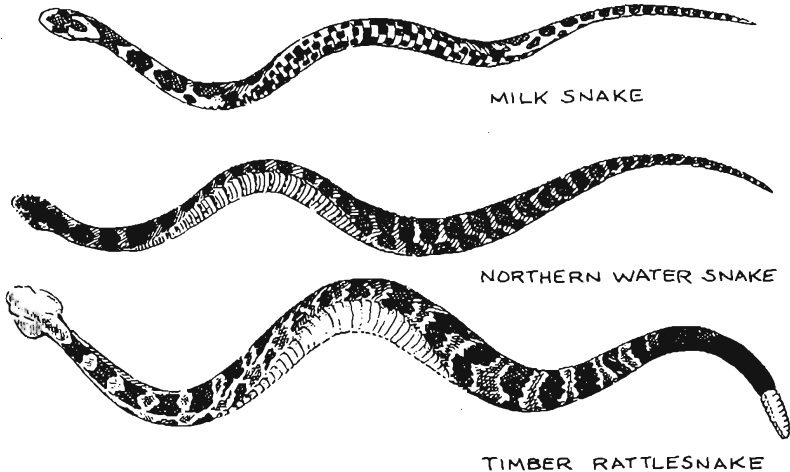
Milk snakes hibernate from late fall (October or November) until April. Suitable cover or material for egg laying is considered to be a special habitat requirement.

**REPRODUCTION:** Milk snakes reach sexual maturity at three to four years of age (Fitch and Fleet 1970). Mating occurs in June, often under cover. The species is oviparous, with 5 to 24 (average of 13) eggs laid by early July. A variety of places are used for egg deposition such as manure or sawdust piles, soil or sand, and under rubbish, logs, or boards. The young snakes, about 17–26 cm (7–10") in length, hatch from late August to October (Fitch and Fleet 1970; Williams 1988).

**DIET:** As one might expect, given the wide range of habitats used, milk snakes have a diverse diet. Depending on prey availability, they will hunt and eat mice, other small mammals, snakes, birds, eggs, lizards, and amphibians (Williams 1988). They usually forage at night, and prey is killed by constriction (suffocation induced by tightening around the prey).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Although the milk snake is harmless to people, they will strike aggressively and bite when handled. They are considered to be beneficial by knowledgeable farmers because of their propensity to hunt rodents, even around buildings. Just as milk snakes eat a wide variety of animals, they fall prey themselves to creatures such as hawks, mammalian predators, and other snakes.

Arthur F. Ritter III, Manchester, Maine





## NORTHERN WATER SNAKE

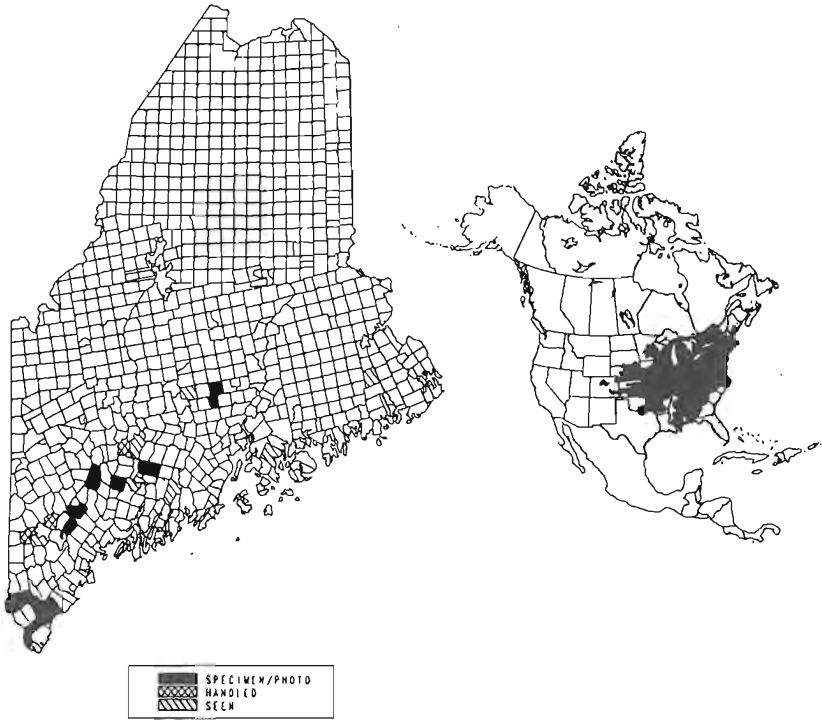
*Nerodia sipedon*

Because this animal will defend itself aggressively when handled, and because it is a fairly large snake (by Maine standards), water snakes are feared by many people. However, its first choice when confronted by humans is to escape, and although it can deliver a painful bite, it is nonvenomous and need not be feared or persecuted. In fact, as Maine's most aquatic snake, it is quite an interesting animal. Water snakes are good swimmers, both on the surface and below it, and they are able to catch food in and out of the water. Most observations of this species are of individuals either basking near the water, swimming over the surface, or patrolling the shoreline.

**DESCRIPTION:** This reptile is usually between 61–107 cm (24–42") in length, with females typically larger than males. Females also exhibit a tail that is tapered from the anus, as opposed to the male's stouter tail. Coloration is highly variable, although they are generally dark in color with a banding pattern forward, and with lateral and dorsal blotches over the rest of their length. The snake's base color ranges from dark brown to a pale gray, with reddish brown to black markings. The ventral pattern often consists of black or reddish half moon shapes, sometimes in a regular pattern, sometimes scattered. Scales are keeled, with the anal scale divided. Although this is by far the most aquatic snake in Maine, be cautious in assuming that any



## Northern Water Snake



snake seen in or alongside a Maine pond, stream, or wetland is a northern water snake. Other serpents, most notably the garter snake and ribbon snake, are good swimmers and are often found near aquatic environments. These two species are marked with distinct or vague lines, or with a spotty pattern, as opposed to the water snake's blotches and bands. Another species which is superficially similar on the dorsal surface is the milk snake, although the checkerboard pattern on the ventral side of this species is quite different from that of the water snake.

Young water snakes have a pronounced pattern of black on a background of light gray or brown. They are from 19 to 23 cm (7.5 to 9") long at birth.

**TAXONOMIC STATUS:** Maine's northern water snake is *N. s. sipedon*.

**DISTRIBUTION AND STATUS:** Common throughout the East and Midwest, the water snake reaches its northeastern range limit in Maine. They appear to be largely restricted to southwestern portions of the state, in a region from southern Penobscot County through York County, plus an area around the Moosehorn National Wildlife Refuge in eastern Washington County. They may occur in very low numbers between the Penobscot River and eastern Washington County; there are only two unconfirmed reports from this area.

**HABITAT:** As the name suggests, the water snake is dependent on aquatic and semiaquatic habitats. It is Maine's only snake that is so highly associated with watery areas, although it does not spend all its time in the water. In fact, in a Wisconsin study, open water was used only sparingly by water snakes (Tiebout and Cary 1987). Instead, cattail habitat, only five percent of the total available area, was used 74% of the time. Flooded meadow habitat was also heavily preferred by radio-collared specimens.

Water snakes prefer slow-moving water to fast-running areas, and are intolerant of badly polluted areas. Almost any type of semiaquatic environment is used: streams, ponds, the backwaters near spillways, meadows, bogs, swamps, and even salt marsh habitats. It is less common in forested wetland areas that are deeply shaded, most likely because of a lack of sunny sites for basking. Common basking places are branches overhanging the water, logs, dead vegetation, and boulders. In Wisconsin, perch height was extremely variable, averaging 11 cm (4 in), with the highest perches, on average, used in May (Tiebout and Cary 1987). The maximum perch height recorded during the study was 213 cm (84").

Although water snakes seldom use open water, they are rarely far from water. In Wisconsin, Tiebout and Cary (1987) reported that water snakes were never located more than 6 meters (20') from water, even during dispersal from their hibernacula. These researchers felt that this reptile should be considered an edge species. Dry areas are used for basking, copulation, and temperature regulation. Water is necessary for thermoregulation, escape from enemies, and foraging.

Using radio locations, Tiebout and Cary (1987) reported the mean home range of 10 adult females to be 5.4 ha (13 ac), although a core area of 0.4 ha (1 ac) was used. Instead of maintaining a traditional home range, the water snakes tended to shift their use of localized areas of intense activity during the course of the study.

**REPRODUCTION:** Water snakes breed in April, May, and in the early fall, sometimes in a mass of many snakes. Mating does not occur in the water, but takes place on overhanging branches, rocks, and other terrestrial sites near the water. A female may be courted by several males at the same time, although fighting among them has not been reported. Copulation may last for several hours.

Young are born live from August to October, with the most likely time being late August. Normally, there are 20 to 40 young in a litter, with larger females tending to have large litters. Litter sizes of over 70 have been reported.

**DIET:** This snake is opportunistic in its dining habits. Most prey items are fish or amphibians, although small mammals such as mice and shrews are eaten if they can be caught. In a study of two shallow, meandering creeks in New York, water snakes were often observed actively chasing fish. Their diet

## *Northern Water Snake*

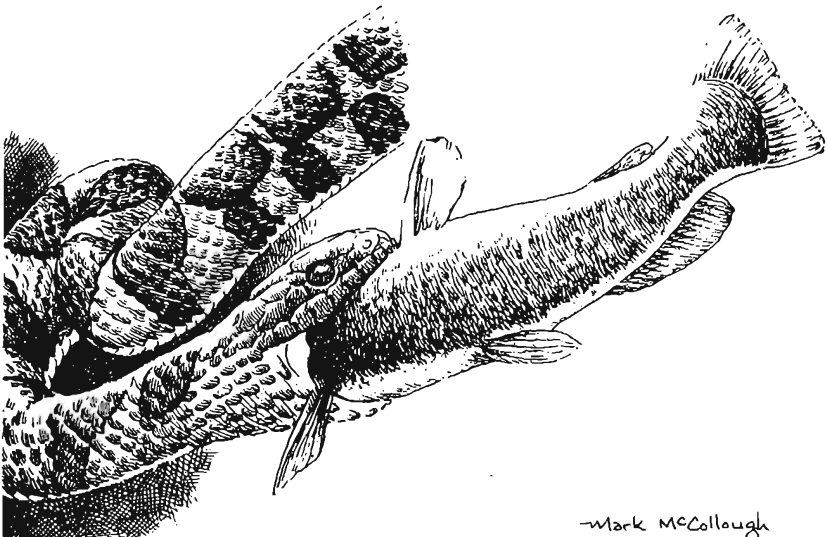
was almost exclusively fish, especially bottom dwellers such as suckers and minnows. Despite the fact that bass lived in the streams, they were never found in snake stomachs examined (Raney and Roecker 1947). Frogs, toads, tadpoles, and salamanders are also taken. Among invertebrates, insects and crayfish are sometimes consumed.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** The water snake's primary relationship with other animals is as a predator for various smaller vertebrates and as prey for larger vertebrates such as raptors and carnivorous mammals.

Where humankind is concerned, water snakes would be better off staying on their own side of the fence. Because they will usually defend themselves when grabbed, water snakes have a reputation for being vicious. In southern states where any dark snake seen near water is a suspected "moccasin," water snakes may be killed in cases of mistaken identity. In Maine there is no reason for this to happen. Some people may dislike water snakes for fear that they will harm game fish populations; however, there does not seem to be any basis for this suspicion (Raney and Roecker 1947).

Water snakes are intolerant of pollution, but on the other hand, certain human-caused alterations may be beneficial. For example, water snakes often frequent rocky causeways and spillways around small dams. Whether or not the original stream provided better habitat than the dammed version could, of course, be debated.

Arthur F. Ritter, Manchester, Maine



*Northern water snake eating a bullhead.*



Mark McCollough

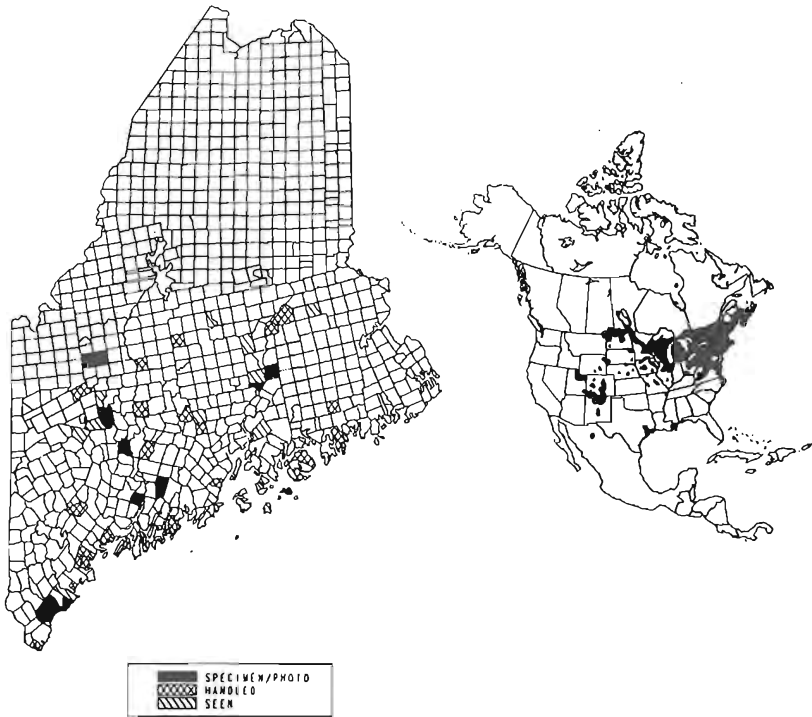
## SMOOTH GREEN SNAKE

*Opheodrys vernalis*

This gentle and common reptile is often called the green snake, grass snake, or green grass snake for obvious reasons: its color and the dominant feature of its habitat. Although often not seen because of its effective camouflage, many people know this species because it is so distinctive and is active during the day. Green snakes generally do not bite and are often captured as pets, but they are difficult to keep in captivity because they often will not eat.

**DESCRIPTION:** This is the only green snake in Maine. The entire dorsum is an even grass green and the venter white or pale yellow. The scales are smooth and the anal plate is divided. Young are a dark olive or blue gray color and are sometimes mistaken for small black racers. After death, green snakes turn a blue color and so are sometimes mistaken for young blue racers. Racers are, however, mottled when young. Green snakes range in size from 36–51 cm (14–20") with a record of 66 cm (26"). Newly hatched young range from 9.6–16.5 cm (4–6.5"). Males have 131 or fewer ventral scales, females 140 or fewer.

**DISTRIBUTION AND STATUS:** MARAP records indicate that green snakes are widely distributed in the southern part of Maine (south of 45° 30'),



with one unconfirmed record from farther north, in Crystal, southern Aroostook County. Their preference for grassy, open areas might explain their apparent absence from the extensively forested regions of northwestern Maine, but it would not account for their apparent absence from the agricultural lands of eastern Aroostook County. They have been reported from an unusual number of island sites. It is not known how long they have inhabited the island locations, but all reports have come from islands that are, or have been, inhabited by humans. This species appears to be declining in southern New England, New Jersey, and Michigan.

**HABITAT:** Green snakes are commonly found in upland meadows and other open areas, including vacant lots, lawns, and gardens in suburban areas. They have been seen in shrubs and on vines, but spend most of their time on the ground. They are also found in open poplar and hardwood stands, bogs, marshes, and brambles. In the northeast, spring emergence usually occurs in April, and hibernation begins in October (Wright and Wright 1957).

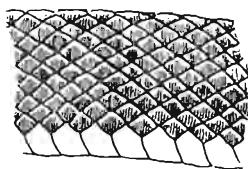
**REPRODUCTION:** Green snakes probably reach sexual maturity in their second year. Breeding occurs from spring until late August in more northerly regions. They are oviparous and the female lays 3–12 eggs, usually about 7, sometime from late July to late August. Eggs range in length from 1.9–3.7 cm and are sometimes laid in communal nests. The largest communal nest

found in Nova Scotia was under a rock and contained 30 eggs, probably the result of six to eight females laying their eggs in that spot. After depositing their eggs in loose soil or under logs, boards, or similar objects, the females leave. The incubation period ranges from 4–23 days, probably depending on temperature and soil conditions.

**DIET:** The green snake diet is composed largely of insects including caterpillars, orthopterans, ants, and flies, as well as occasional millipedes, centipedes, spiders, snails, and salamanders.

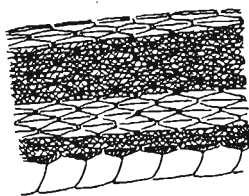
**INTERACTION WITH PEOPLE AND OTHER ANIMALS:** Green snakes are mild tempered and generally flee from humans. They seldom bite, even when being roughly handled, and if they do bite, barely scratch the skin. Human activities have probably affected them in Maine by increasing habitat (open land) in the 18th and 19th centuries and then by allowing the fields to grow back to forest or by destroying habitat with development. The widespread spraying of pesticides has probably also had a negative impact on this largely insectivorous species.

Jane K. Arbuckle, Maine Audubon Society, Falmouth, Maine



**SMOOTH SCALES**

- SMOOTH GREEN SNAKE
- BLACK RACER
- RINGNECK SNAKE
- MILK SNAKE

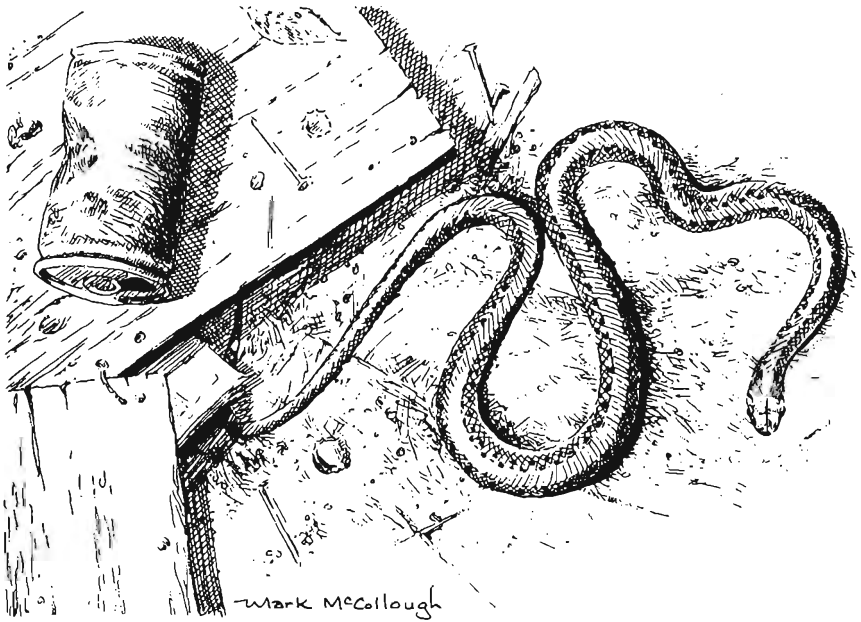


**KEELED SCALES**

- RIBBON SNAKE
- TIMBER RATTLESNAKE
- WATER SNAKE
- BROWN SNAKE
- REDBELLY SNAKE
- GARTER SNAKE

*Maine snakes have either smooth scales or keeled scales. Snakes with smooth scales, like the smooth green snake, have a shiny, glossy appearance.*

*Snakes with keeled scales feel rough.*



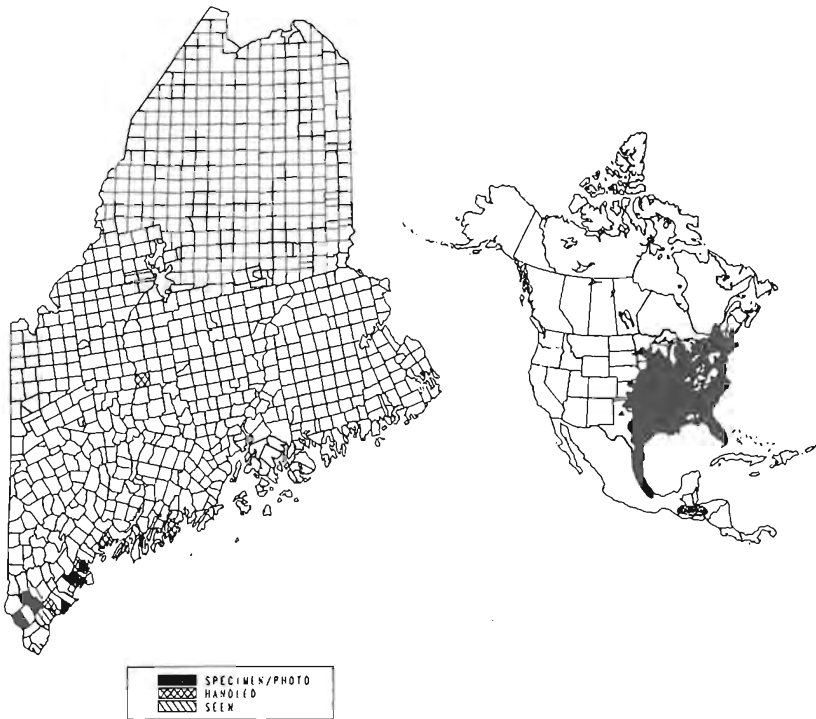
## BROWN SNAKE

*Storeria dekayi*

Cities and snakes are usually incompatible. A ubiquitous, versatile lifestyle allows the brown snake, however, to dwell even in large cities such as Boston, New York, Philadelphia, and Washington, D.C. There it often thrives in parks, cemeteries and vacant lots, hidden much of the time beneath debris. Now and then surprisingly large numbers are discovered, and the unlucky ones are collected for sale in pet stores.

**DESCRIPTION:** Adults are typically 23–36 cm (9–14") in length; the largest specimen on record being 46.7 cm (18.4"). Females tend to be larger than males, but otherwise there are no discernible differences between sexes. The dorsum varies from light grayish brown to dark brown with the lightest color along a mid-dorsal band 3–4 scales wide. This light band is bordered on both sides by a row of black spots that may be absent over the posterior half of the body. There is also a black vertical streak on both sides of the head behind the eyes. The venter varies from pale pink to buff colored without markings except for one or more black specks on the side of each ventral scale.

Newborn juveniles are 8.6–11.4 cm (3.4–4.5") long. They are darker dorsally than the adults. They also have a prominent yellow collar around the neck, which makes them superficially similar to young ringneck and red-



bellied snakes. These other species, however, can be distinguished from the brown snake by dorsal scale characteristics. The brown snake has 17 rows of dorsal scales, while 15 rows occur on the red-bellied snake; in both species these scales are keeled except for the first row. The ringneck snake, on the other hand, has only smooth scales. Brown snakes shed several times during the first three weeks after birth, becoming lighter in color while the neck collar gradually blends into the rest of the color pattern (Clausen 1936).

**TAXONOMIC STATUS:** The brown snake in Maine is *S. d. dekayi*, the northern brown snake.

**DISTRIBUTION AND STATUS:** Few records of the brown snake exist for Maine, where the species reaches a northern limit in its geographic range. DeGraaf and Rudis (1983) document this snake from Oxford, Kennebec, and Hancock counties. MARAP records come from Lincoln, Sagadahoc, Cumberland, and York counties. The species is listed as Indeterminate by the Maine Department of Inland Fisheries and Wildlife, indicating that more information is needed about its status.

**HABITAT:** An ecological characteristic of the northern brown snake is its ability to live under highly diverse conditions from rural to urban and from



dry to moist. Specific habitats include bogs, marshes, swamps, grasslands, forests, trash-littered lots, parks, and cemeteries. Although sometimes found crossing highways, they usually hide under stones, logs, or other debris, venturing out only at night. When hidden, they often occur in aggregations, especially when overwintering. Noble and Clausen (1936), for instance, observed 76 individuals wintering together in an old rat burrow with 10 young eastern garter snakes and a young northern water snake. On another occasion, they discovered 97 individuals scattered in smaller groups within an anthill. They remain quiescent in their overwintering aggregations from October or November until March or April before dispersing, and they have the propensity to return each year to the same winter site.

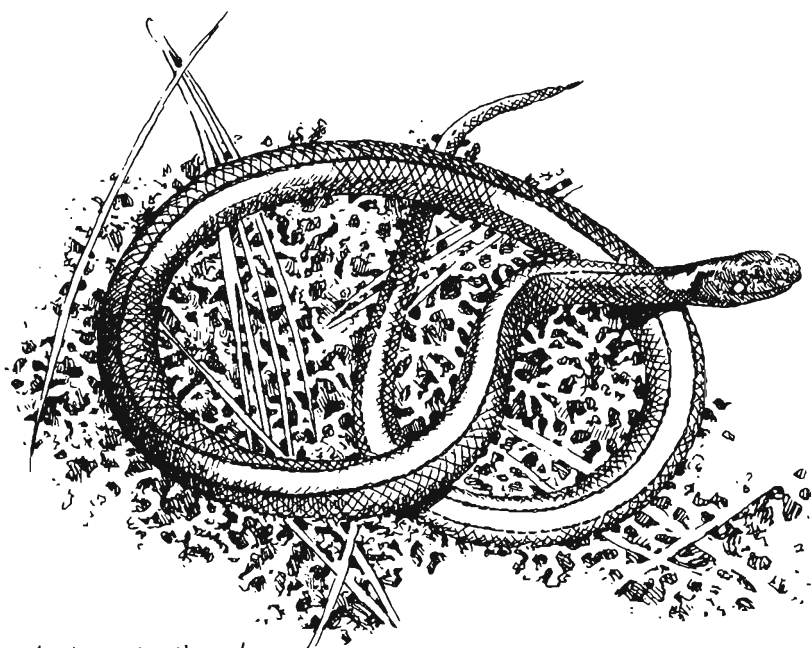
**REPRODUCTION:** Sexual maturity is attained by two years of age. Mating occurs from late March to April and possibly also in the fall. Males locate females by skin odor from glandular secretions (Noble and Clausen 1936). Females isolate themselves during the gestation period of 105–113 days. They are viviparous, giving birth to 3–27 live young during mid-July to August.

**DIET:** Food items reported for the brown snake include slugs, earthworms, snails, insects, minnows, small treefrogs, and tiny toads. Clausen (1936) fed newly born juveniles earthworms and fruit flies. The author's experiences with captive adults have revealed that they engulf voraciously either slugs or earthworms but refuse soft-bodied insects.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Brown snakes are not aggressive. Refusing to bite when handled, they instead release an odoriferous discharge from their anal glands. This, however, does not prevent their ingestion by the predaceous milk and chain king snakes.

That urbanization has not led to the demise of the northern brown snake perhaps is attributable to (1) availability of ample food, including slugs or earthworms, (2) viviparous reproduction eliminating the need for appropriate soils or other substrates in which to deposit eggs, and (3) cryptic behavior and color. Whatever the reasons may be, the brown snake provides us with an ecological success story in adaptability.

Michael Mazurkiewicz, Department of Biological Sciences, University of Southern Maine, Portland



Mark McCollough

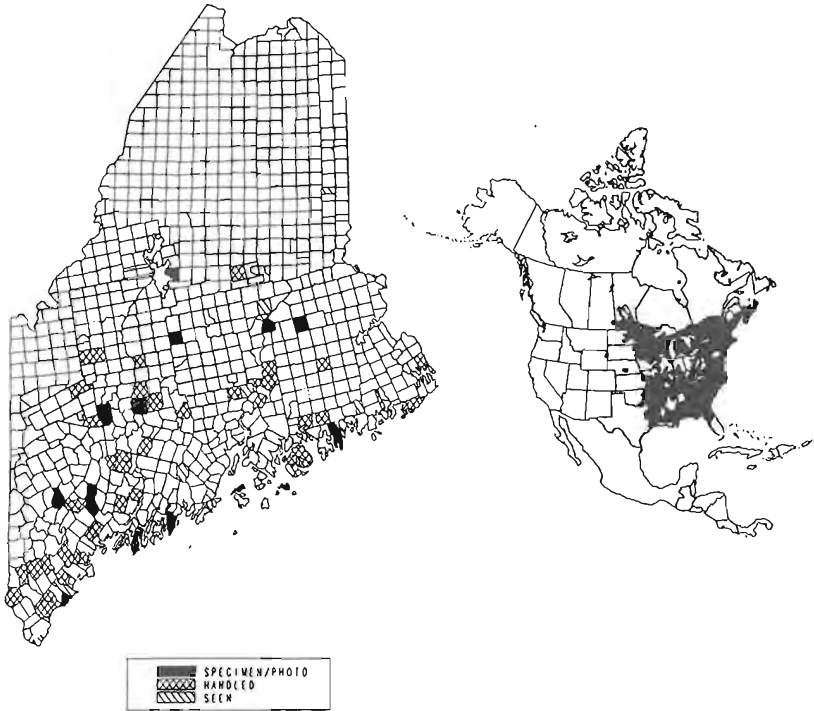
## REDBELLY SNAKE

*Storeria occipitomaculata*

If a person's first experience with a serpent was with a redbelly snake, there would probably be much less ophiophobia (fear of snakes) to overcome. The little redbelly is a gentle creature and, even when first handled, does not bite. This cannot be said for many of Maine's other snakes including the more common garter snake, which often lunges, bites, and defecates to show its displeasure at any attempts to handle it. When first picked up, a redbelly will initially make some frantic attempts to crawl out of the handler's grasp, but will soon slow down and gently slide between the handler's fingers. Though some authors mention a "labial defense" in which a handled snake lifts its upper labials (lips), exposes the teeth on its upper jaw, and presses the side of its head against its captor's hand, this defense is so innocuous or infrequent that even many herpetologists have not noticed it.

**DESCRIPTION:** Scientific names often give a history or description of their possessor and such is the case with *Storeria occipitomaculata*. The genus name tells us that Mr. Storer first described the creature, and the species name refers to the distinctive tan spots located just behind the head, one on the dorsal surface and two others on either side of the neck. In some instances, the dorsal spot may be missing or all three may be fused to form a collar. The snake's common name redbelly gives us a second distinctive

## Redbelly Snake



clue. The entire underside of the snake is a uniform red to red orange color. Much less common is a yellow variation and rarer still are black-bellied individuals. To distinguish specimens with a yellow belly from ringneck snakes, check for keeled scales on redbelly snakes and smooth scales on ringnecks. Brown snakes, which normally have a buff-colored venter, have 17 rows of scales versus 15 in the redbelly.

The dorsal coloration of redbellies is variable, but the two most commonly seen are brown and slate gray. Occasional individuals may be almost black. There may be 4 narrow stripes, a mid-dorsal stripe, or both, running the length of the body.

Total body length for adults is 20–32.5 cm (8–13") with the largest record being 40.6 cm (16"). There are no readily discernible differences between the sexes. Size at birth ranges from 4.5–11 cm (1.8–4.3").

**TAXONOMIC STATUS:** The northern redbelly snake, *S.o. occipitomaculata*, is the subspecies that occurs in Maine.

**DISTRIBUTION AND STATUS:** Most field guides include all but extreme northern Maine in the range of the redbelly snake, but MARAP cannot verify this. The species has been found readily in the southern portion of the state and in the coastal region all the way through Washington County. Records are rare, however, for the western mountains region and absent from north

of Moosehead Lake with the exception of an unverified report from Ludlow, Aroostook County. The secretive nature of the snake and the lack of intensive searching in these areas may partially account for the lack of records.

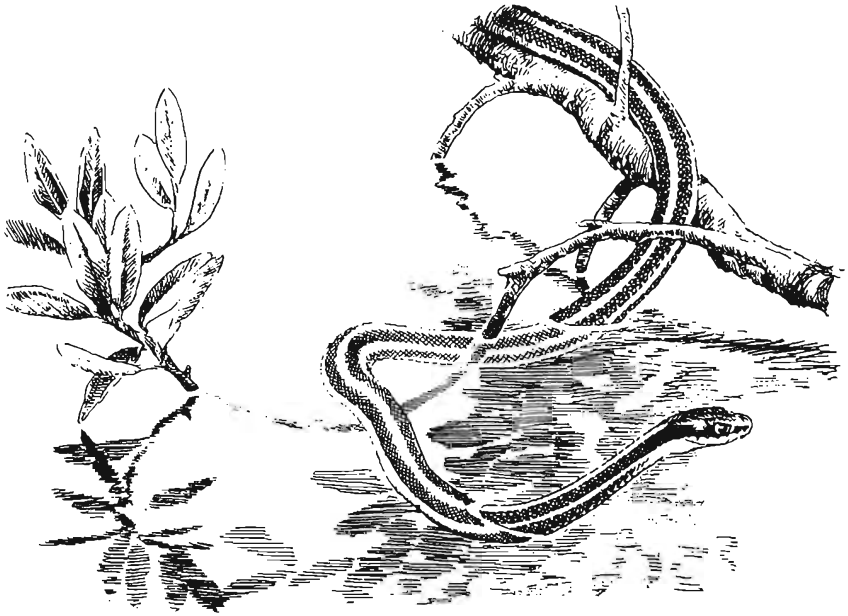
**HABITAT:** Published accounts of the redbelly snake refer to the occurrence of the snake in almost any habitat. These include shoreline areas of ponds, lakes, and streams; cut-over areas and gravel pits; bog, swamp, and marsh edges; and open fields. Woodland is, however, the most commonly mentioned habitat type. It also seems to matter little whether the woodland is moist or dry. Within these habitats, the redbelly takes refuge under a wide variety of surface debris such as rocks, bark from fallen trees, boards, tarpaper, cardboard, and other assorted human rubbish. The author has found them taking refuge in the lower levels of his stacked wood pile along with garter snakes and green snakes. At times, redbellies also burrow below the ground surface, although the degree of this activity is not well known. Reported hibernacula include a gravelly area with 65 individuals together and an anthill with 100 or more (Wright and Wright 1957).

**REPRODUCTION:** Redbelly snakes are viviparous. Males and females apparently mature at 2 years of age at which time they are 22 cm (8.8") or greater in total length (Blanchard 1937). Breeding normally takes place after the adults come out of hibernation in the spring, with the majority of the young being born during the middle of August to early September. Less commonly, breeding has been observed in July, August, and September, and young have been born during all summer months from June to September. Males with mature, active spermatozoa in their vas deferens have been found during the fall (Wright and Wright 1957), and this suggests fall matings occur with fertilization delayed until after hibernation. The number of young produced varies from 1 to 21. In northern Michigan, more than two-thirds of the litters contained 4 to 9 young and had a sex ratio of 1:1 (Blanchard 1937).

**DIET:** Gardeners should love the little redbelly since most of its diet consists of slugs. In addition to these obnoxious pests, redbellies also eat earthworms and soft-bodied insects such as sowbugs and myriopods.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** A species that is as small, secretive, and innocuous as the redbelly is hardly a threat to anyone except its potential prey. Because of its feeding preference for slugs, the bane of moist climate gardeners, redbelly snakes can be considered beneficial to humanity's self-centered interests. With its only defense being its propensity to remain hidden from view, the redbelly is itself potential prey to a host of other species.

Barry Burgason, Enfield, Maine

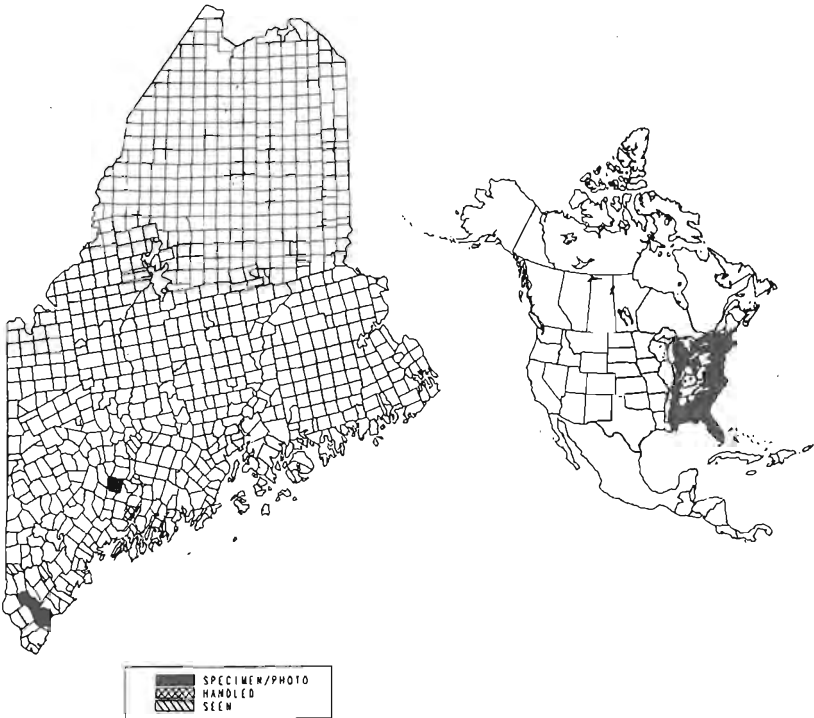


## RIBBON SNAKE

*Thamnophis sauritus*

Eastern and northern ribbon snakes are sleek, boldly striped serpents that are equally at home roosting in shoreside shrubs or gliding swiftly across the water's surface. These agile semiaquatic creatures seldom are found far from dense cover, where they retire at the first sign of danger. In Maine they appear to be both elusive and rare. Garter snakes are quite similar in appearance, and this similarity may be part of the reason why so few reports exist for *T. sauritus*; observers may assume the snake they saw was just a garter snake, Maine's most common snake.

**DESCRIPTION:** Ribbon snakes are small thin snakes with longitudinally striped bodies. They are best distinguished from their close relative the garter snake by their long thin tails, which are about one third of the total body length. Ribbon snakes also have three conspicuous yellow or buffy stripes. Some garter snakes may also have three stripes, but they usually contain alternating rows of dark brown or black blotches between the rows of stripes. In ribbon snakes the lateral striping occurs on scale rows three and four for the entire length of the body (Wright and Wright 1957). Garter snakes usually have stripes on scale rows two and three, and may have stripes on their fourth row of scales, (Conant 1975). Ribbon snakes vary in size from 40–90 cm (16–36"), with the tail accounting for 1/3 or more of the total length (Wright and Wright 1957; Gilhen 1984).



**TAXONOMIC STATUS:** Maine's ribbon snakes, the eastern *T. s. sauritus* and northern *T. s. septentrionalis* ribbon snakes, are part of a four subspecies complex, also including peninsula ribbon snakes (*T. s. sackeni*) and blue-striped ribbon snakes (*T. s. nitae*), that range from Nova Scotia (Gilhen 1984) to southern Florida (Conant 1975).

Eastern ribbon snakes can be confused with northern ribbon snakes, but the latter subspecies has a brownish yellow dorsal stripe that contrasts with their greenish yellow lateral stripes (Gilhen 1984). In the eastern ribbon snake the dorsal stripe and lateral stripes tend to be identically colored. In addition, northern ribbon snakes tend to be black or dark brown on the back, while eastern ribbon snakes are reddish brown (Gilhen 1984). Northern ribbon snakes are usually slightly smaller than eastern and also have tails that are usually slightly less than 1/3 their total length (Conant 1975). Records gathered by MARAP were not sufficient for distinguishing the ranges of the two subspecies in Maine because most observers were not confident of their subspecific identifications.

**DISTRIBUTION AND STATUS:** Southwestern Maine appears to be the northern extent of the ribbon snake's range in Maine with records from several York County towns plus outlier records from Kennebec and Sagadahoc counties. Ribbon snakes have been listed as a Species of Special Concern by the Maine Department of Inland Fisheries and Wildlife. Unless more

populations are discovered in the future, they should be considered for designation as Endangered or Threatened.

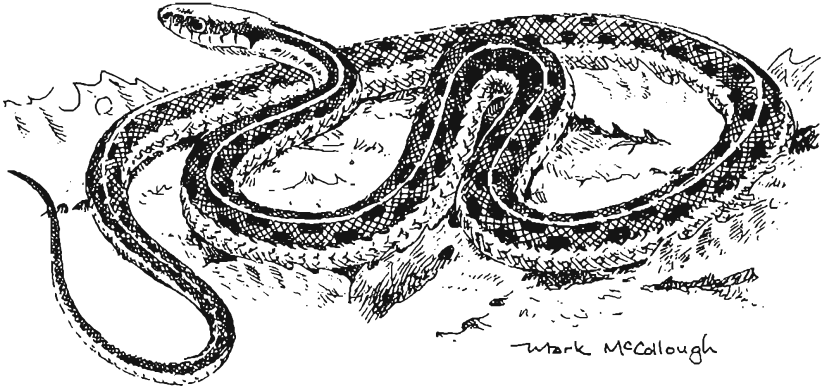
**HABITAT:** Ribbon snakes prefer the edges of wetland habitats that contain bushes and abundant supplies of amphibians (Carpenter 1952). They have been reported from a diversity of wetland habitats including streams, ponds, lakes, swamps, marshes, and bogs (Wright and Wright 1957). In Maine, ribbon snakes have been observed along shores of lakes and ponds in herbaceous vegetation and scrubby swales. These snakes swim readily along the surface of water when traveling or fleeing (Carpenter 1952). Gilhen (1984) observed that northern ribbon snakes hid under water, among aquatic vegetation, when they were approached by humans. However, it is not known if they swim under water as readily as water snakes do. Carpenter (1952) reported that eastern ribbon snakes in Michigan hibernated in grassy pastures that were well drained and contained clumps of sumac. He also reported ribbon snakes hibernating in an ant hill.

**REPRODUCTION:** Eastern ribbon snakes breed primarily in the spring and summer, although sometimes they will breed in the fall (Carpenter 1952). In Michigan, during June, July, and August, Carpenter (1952) found 65 percent of adult female eastern ribbon snakes to be gravid, and 22 percent of all females (juveniles plus adults) to be gravid. He reported an average litter size of 10 young, from 5 females. Ribbon snakes are viviparous and most young are born in mid- to late summer (Wright and Wright 1957). Northern ribbon snakes are believed to have similar reproductive strategies as eastern ribbon snakes. Minton (1972 in DeGraaf and Rudis 1986) reported that northern ribbon snakes probably breed in spring and fall and that young are born in July and August.

**DIET:** Ribbon snakes primarily eat amphibians (Carpenter 1952), although they will also eat insects, spiders, small mammals, and fish (Wright and Wright 1957). These snakes opportunistically feed on more abundant and easily captured metamorphosing amphibians (Carpenter 1952). In an in-depth ecological study conducted in Michigan, Carpenter (1952) reported that amphibians formed 90% of the diet of ribbon snakes, with other identifiable food items consisting of fish and caterpillars.

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Specific information regarding predators of eastern ribbon snakes is not available. Predatory birds and mammals, particularly those species associated with wetlands, are probably the most common predators of ribbon snakes. Activities that degrade water quality through pollution may affect ribbon snakes by decreasing the availability of prey items. In addition, the filling of wetlands removes available habitat for ribbon snakes.

John P. Lortie, Durham, Maine



## COMMON GARTER SNAKE

*Thamnophis sirtalis*

Capable of flourishing in all but the most urbanized landscapes, garter snakes are the most abundant reptiles in Maine. Dozens may be found together in particularly suitable habitats such as old, abandoned homesteads where boards and debris lay strewn about. These striped and spotted snakes are among the first to emerge from the ground in spring, frequently basking on sun-warmed rocks in March. In autumn they may not retreat to their hibernacula until November.

**DESCRIPTION:** The garter snake is strikingly variable in pattern and coloration, even within the boundaries of Maine. Typically, this snake has three yellowish or brownish stripes on its dorsum. Between the center stripe and the lateral stripes are two rows of alternating black spots. The center stripe may be so dark or obscure that in some individuals the spots are the dominant feature of the snake's appearance. Such snakes have been described as a separate subspecies, the maritime garter snake, *T. s. pallidulus* (Bleakney 1959), and are discussed under Taxonomic Status. Background color of the dorsum may be nearly black to olive. The venter is greenish or yellowish with a pair of partially obscured, small, black spots on each ventral scale.

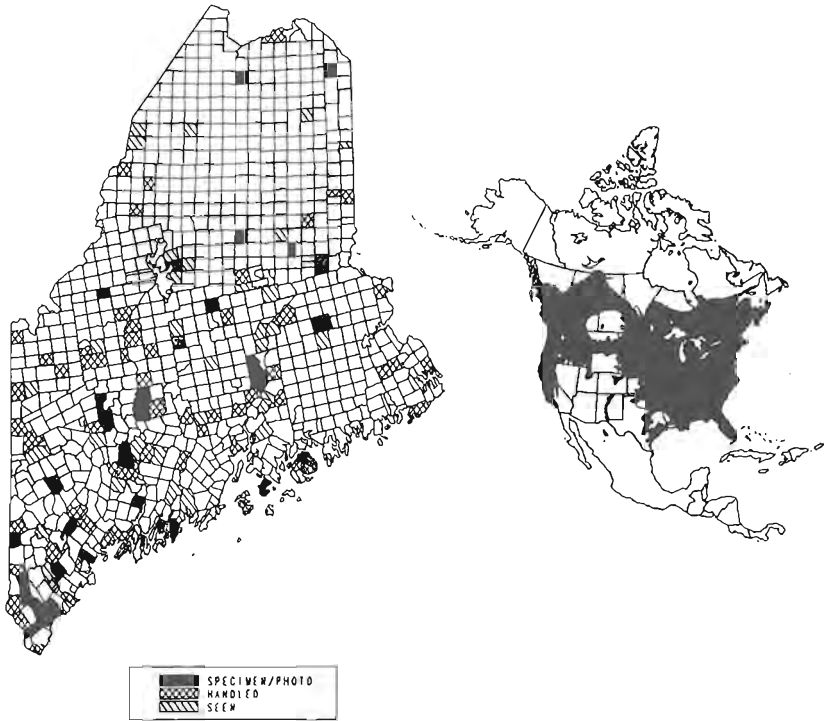


Garter snakes can be differentiated from ribbon snakes by the lateral line, which always appears on the second and third scale rows in garter snakes versus the third and fourth in ribbon snakes. Ribbon snakes also have longer tails than garter snakes. In ribbon snakes the tail typically is 1/3 or more of the total body length, whereas in garter snakes the tail is 1/4 or less of the total length. Young garter snakes are sometimes confused with other species of small snakes, but their combination of keeled scales and an undivided anal scale will separate them from species such as brown, redbelly, and ringneck snakes. Mature garter snakes can be sexed by noting the degree of tapering beyond the anal scale. In females the taper is abrupt, whereas in males there is little or none. Usually garter snakes range in size from 46–66 cm (18–26"), but the largest Maine specimen on record measured 111 cm (44"). Young garter snakes measure 13–23 cm (5–9") at birth.

**TAXONOMIC STATUS:** The common garter snake inhabits a large part of Canada and most of the continental United States, and it is highly variable throughout its range in scale measurements and color. Fitch (1980) described 12 different subspecies of this snake. The so-called maritime garter snake, occurring in the maritime region of Canada and adjacent parts of northern New England, was first described by Allen (1899) in New Hampshire. Subspecific status was not initially accepted, however, because many garter snakes from other parts of the east showed similar deviations in pattern and coloration. Bleakney (1959) later discovered that this color form was fairly consistent over an extensive area and promoted its recognition as a subspecies, *T. s. pallidulus*.

The primary means by which the maritime subspecies is differentiated from the eastern subspecies, *T. s. sirtalis*, is by the loss or greatly reduced appearance of the dorsal stripe. Haskins (1986) investigated the distribution of the eastern and maritime subspecies in Maine by examining 37 specimens collected from throughout the state except the extreme northwest. He found that examples of both subspecies could be found throughout the state, but that there was a fair amount of segregation. The eastern subspecies predominated in the southwestern part of the state, i.e., west of the Penobscot River and south of the mountains of western Maine; elsewhere the maritime subspecies was most common. It has been postulated that snakes in more northerly areas have evolved into darker forms with less conspicuous dorsal stripes because darker snakes may be less likely to be detected by predators on a forest floor comprised mainly of conifer needles.

**DISTRIBUTION AND STATUS:** The garter snake probably occurs throughout the entire state including many coastal islands and mountainous areas over 1,000 meters in elevation. Populations may be less dense in coniferous forests due to the acidic soils, which are not as favorable for earth worms, their main prey. Still, they are by far the most abundant reptile in Maine.



**HABITAT:** Garter snakes are found in a wide variety of habitats including fields, marshes, forests, wood edges, rocky hillsides, edges of streams and ponds, and developed areas such as city lots, parks, cemeteries, and suburban lawns. They seek shelter under objects such as stumps, rocks, logs, boards, wood piles, and scrap metal. Hibernation may occur singly or in large numbers in holes, rock crevices, anthills, rotten wood, mud banks, house foundations, and old stone wells (including submergence in water). These snakes have been known to survive part of the winter above frost line (Bailey 1949); at 45 cm (18") below the ground surface, garter snakes have withstood temperatures of -1.5°C (29°F) for 18 continuous days and -2.2°C (28°F) for 28 days. Sustained winter submergence in water may also have survival advantages for garter snakes (Costanzo 1986). A group of over 200 garter snakes used an abandoned cistern as a denning site; beneath the ice, they presumably found a stable thermal regime, desirable thermal microsites, and a means for preventing dehydration.

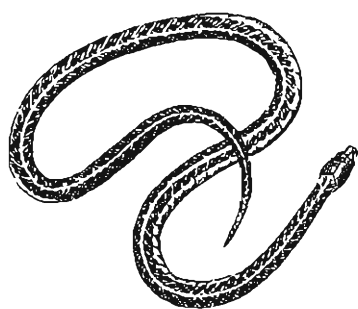
**REPRODUCTION:** Sexual maturity is reached at a length of about 50 cm (20") for females and 40 cm (16" for males). They breed soon after leaving hibernation in mid-March to May and sometimes in the fall, with the female storing sperm until spring. During courtship, one or several males may pursue a female by following her scent trail; however, usually only one will

eventually copulate with her. Typically, the male approaches the female from behind and crawls alongside her body pressing his chin to her back. This may go on for some time before he finally entwines his tail with hers (providing she is receptive) and inserts one of his hemipenes into her cloaca. The entire mating ritual may last in excess of an hour. Garter snakes are viviparous, and the females give birth anytime from July to early September. In cool climates, the gestation period may last 4 months. Females usually give birth to 14 to 40 young, depending on their size and age. As few as 3 young and as many as 85 have been recorded. Zehr (1962) found the number of young in New Hampshire to average 12 to 13.

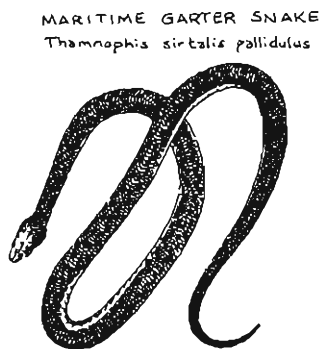
**DIET:** Although earthworms constitute 80% of the food taken by garter snakes, many other animals are also preyed upon, depending on availability, such as amphibians, fish, carrion, leeches, insects, small birds, rodents, reptiles, molluscs, and crayfish. Young snakes are known to take earthworms, slugs, insects, and small frogs and toads (Hamilton 1951).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** As a defensive posture, garter snakes may flatten their bodies when alarmed, thus displaying their colors more vividly. If captured, they usually discharge a sweetish, unpleasant-smelling musk from glands located at the base of their tail. Their temperament is variable. Some newly caught specimens are docile and will take food from a hand immediately, while others may bite vigorously in self-defense and continue to strike many days after their capture. Although garter snakes frequent developed areas, they are not immune to pollution. One study in New York revealed that pesticides had reduced local populations significantly (Gochfeld 1975). Garter snakes are preyed upon by hawks, skunks, foxes, coyotes, raccoons, domestic cats, and other snakes such as milk snakes and black racers. A large number also meet their fate on roadways and at the hands of people whose fear or ignorance induces them to kill these creatures.

Jaime J. Haskins, Owls Head, Maine



EASTERN GARTER SNAKE  
*Thamnophis sirtalis sirtalis*



MARITIME GARTER SNAKE  
*Thamnophis sirtalis pallidulus*



## TIMBER RATTLESNAKE

*Crotalus horridus*

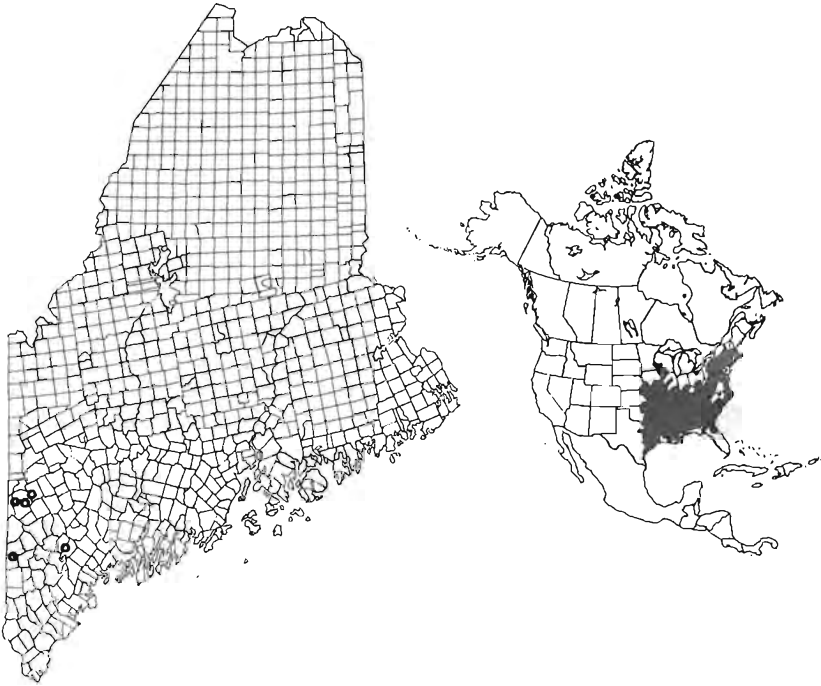
When Maine reptiles are the inspiration for idle speculation, rumor, and exaggeration, the existence of rattlesnakes and the size of snapping turtles are the favorite topics. In fact, whether or not Maine is the only state of the lower 48 to be without venomous snakes has also been of considerable interest to herpetologists throughout the country (Palmer 1946). Among professional herpetologists the uncertainty is engendered by the absence of any museum specimen of a Maine rattlesnake. However, scientists now accept the fact that a valid specimen once existed until it was destroyed in the Great Portland Fire of 1866 (Hunter 1985). Among Mainers in general, the rattlesnake is a recurring topic because of the pervasive fear people harbor for venomous snakes and because potential sightings are regularly reported. Without question the vast majority of these reports are spawned by milk snakes, a fairly common species that bears a superficial resemblance to a rattlesnake. (Some reports are totally unrealistic; one dead "rattlesnake" turned out to be an eel.) Despite the absence of confirmed reports, rattlesnakes may still persist in Maine. Adequate habitat remains at several sites, and it is quite possible that a rare, shy, largely nocturnal animal could go uncollected for a very long period.

**DESCRIPTION:** Timber rattlesnakes are variable in color, ranging from yellow through gray or brown to almost black. They are more heavy-set than any other Maine snake and, although they have been known to reach 188 cm (74"), more typical lengths are 90–130 cm (roughly 3–4'); newborn young are usually 20–30 cm.

There are only three Maine snakes that have dorsal blotches, saddles, or bands—the timber rattlesnake, the northern water snake, and the milk snake—and they all have very different venters. The rattlesnake is almost uniformly light below with just a little dark flecking; the milk snake has a distinctive black and white checkerboard pattern; and the water snake has reddish and black crescents. Of course, the rattler also has a tail that ends in a series of loose, horny segments—a rattle which it often uses to make a warning sound when disturbed. The number of segments is *not* equal to a rattler's age. Although their tails are unique, rattlesnakes are not the only snake to rattle. Milk snakes, black racers, and other species will vibrate their tail rapidly when disturbed, and among dry leaves this can produce a rattling sound. (Some people assume that these snakes shake their tails to imitate a rattlesnake, but snakes in the Old World, where there are no rattlesnakes, also exhibit this behavior. Apparently tail-shaking is an ancient characteristic of snakes, and the rattlesnake's special tail evolved to accentuate this display.) Timber rattlesnakes have keeled scales, usually in 23 (up to 25) dorsal rows; milk snakes have smooth scales in 19–23 rows. Males usually have longer tails, but there is no reliable external cue to differentiate the sexes.

**DISTRIBUTION AND STATUS:** In the absence of any documented records since the mid-nineteenth century, one has to assume that the rattlesnake has been extirpated in Maine. After a thorough analysis of the writings of early naturalists, Arthur Norton (1929a) concluded that rattlesnakes had been of rare, but regular, occurrence in southwestern Maine and may even have been quite common at two sites: Rattlesnake Mountain in Casco and another mountain of the same name in Albany Township. On the accompanying map these mountains and other geographic features with similar names are marked; it is not unreasonable to speculate that rattlesnakes once occurred in suitable habitat throughout the portion of Maine south and west of these points. Some early authors stated that rattlesnakes were unknown east of the Kennebec River; another gave the Androscoggin River as the eastern limit. More recent, but unconfirmed, reports have come from as far east as the Camden Hills and from as far north as Farmington. Timber rattlesnakes still occur in New Hampshire, Vermont, and Massachusetts, but are rare and their numbers are probably declining.

**HABITAT:** Timber rattlesnakes are most often seen near the rock crevice dens where they return each year, sometimes in large numbers, to hibernate. These sites are traditional; indeed some have been known to persist for over a hundred years and are probably much older. They are typically on rocky,



brushy hillsides that face south, allowing the snakes to sun themselves in spring and fall. Herpetologists have usually reported the timber rattlesnakes' primary summer habitat to be quite similar to the denning habitat—open forests on rocky hillsides—but a Pennsylvania study using snakes equipped with radio-transmitters found that they move into dense forest with a thick understory and relatively few rocks (Reinert 1984). Primary habitats aside, they can occasionally be found in a wide variety of environments, even swamps and stream sides. A common feature of their habitat is remoteness; it seems that either they avoid areas frequented by people, or have been eliminated in densely populated areas.

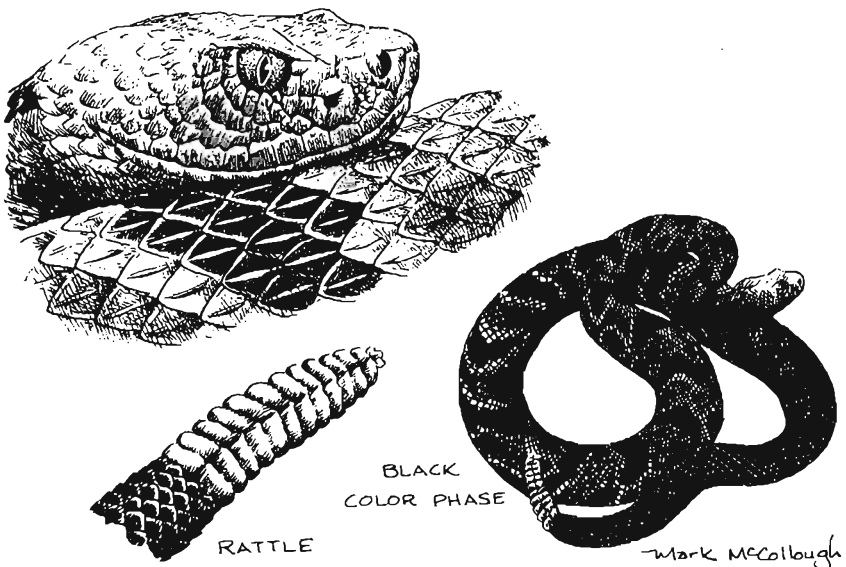
**REPRODUCTION:** The mating behavior of timber rattlesnakes is not well known. Apparently they mate at the den site; sometimes in the fall, sometimes in the spring. The females are viviparous, producing 5–17 young in late summer, probably near, but not at, the den sites. In a study of timber rattlesnakes in the Adirondacks, females reproduced only at 3- or 4-year intervals and most did not begin to reproduce until they were 9 or 10 years old (Brown 1991). This limited reproductive capacity may partly explain why they have become uncommon in the northern parts of their range.

**DIET:** Small mammals such as mice, voles, squirrels, shrews, and chipmunks are their major source of food, although they occasionally eat birds

and rarely, other snakes. Their preference for warm-blooded prey is related to a pair of organs called facial pits, between their nostrils and eyes, with which they can detect the heat radiating from a warm-blooded animal. They hunt mainly at night, usually by simply waiting to strike at a mammal that comes too close, then using their sense of smell to track it until the venom takes effect. Often they will coil up next to a log, their head resting on it, and wait to ambush their prey as it comes down this runway (Reinert et al. 1984).

**INTERACTIONS WITH PEOPLE AND OTHER ANIMALS:** Because they are venomous, rattlesnakes are greatly feared by people, and thousands have been killed at their den sites. In states where they were once common, many towns used to sponsor organized hunts and pay bounties. Even in Maine, such hunts took place occasionally in the 19th century, and it is rumored that as many as 100 rattlesnakes were killed in a day on Rattlesnake Mountain in Casco (Fobes 1951). At least one person treated the snakes as a resource, not mere vermin, and extracted snake oil to market in Portland. Now the timber rattlesnake is rare in the Northeast and many states consider it an endangered species. Fear of timber rattlesnakes is largely unfounded; compared to some venomous snakes, timber rattlesnakes are not especially aggressive or venomous, and very few people have ever been injured by one. Despite their venom and warning system, rattlesnakes are not immune to predators; raptors and carnivorous mammals capture them occasionally and apparently deer go out of their way to stomp on them. Rattlesnake dens are often shared with other species of snakes such as black racers, milk and garter snakes.

Malcolm L. Hunter, Jr., Wildlife Department, University of Maine, Orono



## FINDING AND ENJOYING AMPHIBIANS AND REPTILES

Many encounters with herps are entirely fortuitous. You may be driving down the road and spot a female snapping turtle looking for a place to lay her eggs, or you may be raking leaves by your camp and uncover a redback salamander. If you want to find some of the less common species, however, it will require more concentrated effort.

Throughout most of Maine a herpetologist's year begins in April because as soon as most of the snow is gone from the woods, a warm, rainy night will bring out hordes of salamanders. For the group of salamanders collectively called the mole salamanders (*Ambystoma*), this is about the only time of year they are found above ground. They move overland to gather and breed in ephemeral woodland pools where there are no fish to prey upon their young. These pools are easily located by listening for the calls of another early emerging amphibian, the wood frog. A little later, spring peepers may often be found in the same sites.

Probably the best way to find amphibians is to go out on a warm, rainy night, especially during the spring breeding season, and drive slowly down back roads. If you have two people, a driver to watch the road and someone with a flashlight to jump out and carefully inspect the critters, you can cover a great distance and then return to the hot spots for more thorough searching.

Reptiles usually make their appearance a couple of weeks later, when they can be found basking in sunny spots. Snakes are often concentrated near their winter dens at this time, so you should seek out rocky, south-facing hillsides on sunny days in May. Snakes may be more wary than is commonly realized, and it is advisable to be quiet and stealthy when looking for basking snakes.

Summer is the prime season for finding both amphibians and reptiles, and something can be found in just about any habitat at any time of day. As a generalization, sunny afternoons are the best time to find reptiles and rainy nights the best time to find amphibians. Frogs are very easy to find during their breeding season because of their loud choruses. Late May and June are the most active periods in Maine for most species.

The shores where aquatic and terrestrial habitats come together are excellent spots for finding Maine herps. Paddling or walking along a shore is likely to produce a variety of frogs, turtles, and snakes, particularly if there is a good growth of aquatic vegetation. The banks of small woodland brooks are also great spots for finding salamanders; dusky, two-lined, and spring salamanders are almost exclusively tied to this habitat although you will have to turn over stones and logs to find them except on rainy nights. After a short while, you will learn to recognize the one stone in 25 that is likely to conceal a salamander. Turning over logs, stones, and boards is a standard searching technique for herpetologists. In forests and forest edges, it will



produce redback salamanders, ringneck snakes, brown snakes, and redbelly snakes. If you work along a stone wall between a forest and a pasture, you might also find a garter snake, green snake, black racer, or milk snake. In an area you visit regularly you might put out some artificial cover; old boards are perfect for they are easy to find and flip over. Incidentally, always flip an overturned log or stone back into its original position to maintain the habitat of herps and other species.

Although finding herps is great fun for naturalists, most encounters between herps and people, even well-intentioned people, are not enjoyable for the herp. To minimize the stress of such encounters, keep them short and learn to hold the animal properly. Be firm but gentle; an animal thrashing about is likely to injure itself and, in the case of large turtles and snakes, perhaps you. Use wet hands to minimize the damage to amphibians' protective layer of slime. Support the animal's weight; a snake dangling by its neck can hurt itself.

In some cases you can enjoy observing herps without handling them. Try watching frogs and turtles in a pond with binoculars, or sitting quietly by a woodland pool on a spring night to observe the mating rituals of various frogs and salamanders.

Keeping herps as pets is a long-standing tradition—what would grammar school biology be without frogs eggs to watch develop? In recent years, however, conservation and ethical issues have made many people think twice about their desire to keep unusual pets. Two points will suffice here. First, it is illegal to keep some Maine herps as pets; see the section on Conservation for details. Second, most captive herps have a limited repertoire of behavior and should be released where they were captured when they are no longer interesting to observe.



## HYPOTHETICALS, ACCIDENTALS, AND OTHER ODDITIES

For most naturalists, observing something that few others have seen is exciting. And for Maine naturalists, there are a number of herp species that offer interesting potential for discovery. These are the hypothetical, the accidental or vagrant, and the exotic species of herps that have made their way, or might someday make their way, into Maine herpetology lore.

Although accidental and exotic species of herps are interesting, it is the group of species we consider "hypothetical" that are potentially most ecologically significant. Hypothetical herps are those species that have never before been observed in Maine but could occur here. Our suspicions, or expectations, that we will find them in Maine are based on their occurrence in adjacent regions and the availability of suitable habitat in Maine, or simply the impression that "they're here, but we haven't seen them yet."

The following brief accounts highlight these hypothetical species, and may help you know when you have found something especially unusual, or perhaps give some clues about how and where to look for them.

### **Marbled Salamander** *Ambystoma opacum*

This species, a close relative to our blue-spotted and spotted salamanders, is currently known from New Hampshire and could occur in southern Maine. It breeds in autumn, and the larvae would be seen in early spring, before other species have laid eggs.

### **Jefferson's Salamander** *Ambystoma jeffersonianum*

This is the "original" species of the Jefferson complex consisting of the Jefferson's and blue-spotted salamanders and their various hybrids, and it may occur in southern Maine. See the blue-spotted salamander account in this book for details about this group.

### **Slimy Salamander** *Plethodon glutinosus*

The slimy is a slightly larger and darker relative of the redback salamander. It occupies similar habitats as the redback, including ravines and hillsides, and has been reported in southern New Hampshire. Its nasolabial (nostril to lip) groove distinguishes this species from mole salamanders; its larger size and dark throat and venter distinguish it from the lead phase redback.

### **Fowler's Toad** *Bufo woodhousei fowleri*

This is the famous "bleating" toad that sounds like a sheep. It breeds later in the season (ca. late June through mid-August) than the American toad, and requires sandier soils. This toad occurs in southern New Hamp-

shire, and if it occurs in Maine, it will most likely be found in the sandy regions of the extreme southern or southwestern portions of the state.

**Hognose Snake *Heterodon platyrhinos***

This species is also reported from southern New Hampshire and, like the Fowler's toad, prefers sandy areas. This snake can be confused with the garter snake. The hognose is larger, and its upturned snout and excessive hissing and "possum" behavior distinguish it. A credible MARAP volunteer reported this snake from western Maine, but neither a specimen nor a photo was obtained, so the record remains unauthenticated.

**Black Rat Snake *Elaphe obsoleta***

This large black snake is not likely to occur in Maine, although it is apparently extending its range northward in the Connecticut River valley. We list it here because there have been undocumented reports of it from Maine. These reports were probably misidentified black racers, or very dark garter snakes.

**Five-lined Skink *Eumeces fasciatus***

Even though this lizard was actually reported from Maine by Dr. Benjamin Fogg in 1862, no specimens or other records exist, and we therefore consider it as hypothetical. It may have inhabited the same warm, dry talus slopes as the timber rattlesnake, a habitat the skink currently occupies in Vermont. If it occurs in Maine, it will be in similar habitat in the mountains and hills of southwestern Maine. We consider this unlikely, however, since it has not been reported since Dr. Fogg's notes, and the nearest extant populations are in Vermont and southwestern Connecticut.

What should you do if you find one of these hypothetical species in Maine? The most important objective is to document what you are seeing. If you have a camera, take *many* pictures at differing angles and distances so that a positive identification can be made from the photo. If you have no camera, try capturing the animal alive. Write down when and where you found the animal so it can be returned later; be very specific and detailed. Immediately contact either your regional fish or wildlife biologist, or the Endangered and Threatened Wildlife Group of the Department of Inland Fisheries and Wildlife. They can help you directly, or put you in contact with someone who can verify the identification with you and determine the next appropriate steps.

Accidentals, or vagrants, are species that may occur sporadically in Maine, but not regularly enough to merit full native Mainer status. Birders are familiar with this phenomenon, and routinely observe vagrant species that have flown, or have been blown by storms, into Maine. In general, herps are not as mobile as birds, but Maine's only true vagrant herp species are flyers in a different medium—sea water. Three species of marine turtles, the

Atlantic leatherback (*Dermochelys coriacea*), the Ridley (*Lepidochelys kempii*), and the Atlantic loggerhead (*Caretta caretta*) frequent the Gulf of Maine and occasionally are discovered beached or tangled in fishing nets in Maine's territorial waters. Scattergood and Packard (1960) noted thirty records for the leatherback in Maine waters, and one record each for the ridley and loggerhead turtles. Two other marine turtles, the Atlantic green (*Chelonia mydas*) and the Atlantic hawksbill (*Eretmochelys imbricata*) also have been reported from the Gulf of Maine, but have yet to be observed on our shores.

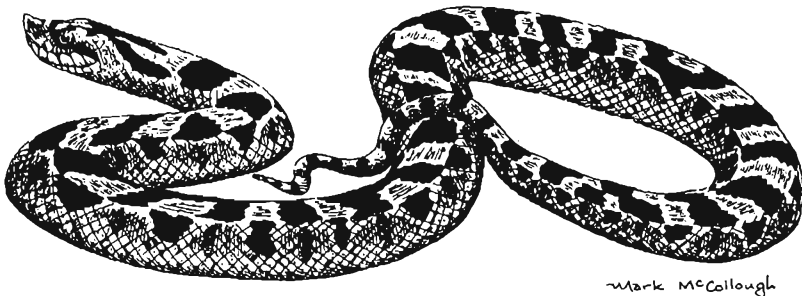
Exotic herps are those species whose presence in Maine is clearly a result of human intervention. The list of exotic species documented in Maine include such obvious foreigners as the boa constrictor (Lowe 1929), the horned lizard (Abbot 1922), the red-eared turtle (McCollough pers. com.), and the diamondback rattlesnake (Palmer 1946). These records are of individuals that were far outside of their normal range and habitats and could not survive in Maine.

Not all exotic species, however, are short-lived. The mudpuppy was brought to Maine by a biologist who was using them in biology classes. Some of the animals escaped from the outside rearing pens, and now mudpuppies are well established in the Belgrade Lakes chain.

It is not always easy to explain the occurrence of exotic species. For example, specimen lists of the U.S. National Museum include a specimen from 1883 labelled "*Ambystoma tigrinum*," the tiger salamander, from Auburn, Maine. Is this specimen an escaped pet, or a misidentified spotted salamander? Exotic individuals of species historically or currently extant in Maine can be more perplexing. Were the box turtles found in Portland, Scarborough, and Herman native individuals, or pets imported from other states and subsequently released by humans?

We clearly do not yet know all there is to know about Maine's herp fauna, and it is still possible to make new discoveries. The only way to know what is here—and what is not here—is to keep looking. Someone once said it this way: "I won't believe it's not here until I don't find it."

John Albright, Maine Natural Heritage Program, Augusta



Mark McCollough

*Eastern hognose snake.*

## METHODS OF THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT, MARAP

MARAP was an undertaking of amateurs motivated by personal curiosity and the desire to increase our knowledge of herps, particularly in a conservation context. This approach had many advantages; for example, it greatly increased interest in herps within Maine's community of naturalists and it was very economical. On the other hand, the depth of information gathered was more limited than would have been possible if a group of professional herpetologists had been hired to survey the state's herpetofauna. This section is an overview of how MARAP worked for those who wish to understand the development of this book, or who might wish to undertake a similar project. It is essentially a distillation of the project's instruction manual, "A preliminary guide to finding and identifying the amphibians and reptiles of Maine" (Hunter 1985), which is no longer in print. It also contains some evaluation of how well the methods worked.

The instruction manual provided two main types of information: how to find and identify Maine herps, and how to fill out MARAP record cards. For each species there were suggestions about when and where to find it, plus diagnostic features for distinguishing it from all other species known to occur in Maine. Some information was also provided about species previously unreported in Maine that might occur here.

The manual assigned species to four different priority levels:

- Priority 1* species had never been recorded in Maine or were believed to be extirpated or extremely rare (e.g., box turtle).
- Priority 2* species were believed to be very uncommon, but probably still had viable populations in Maine (e.g., wood turtle).
- Priority 3* species were common in some parts of Maine, but probably absent from other parts (e.g., painted turtle).
- Priority 4* species were common throughout Maine (e.g., redback salamander).

Depending on a species' priority level and expected distribution different instructions were given. For Priority 1 species we asked that the reporter take the specimen home and call a MARAP coordinator immediately. We went to photograph the specimen as soon as possible and helped return it to the capture site. With Priority 2 species we asked that a photograph be taken and a record card be submitted as soon as possible. We asked that Priority 3 species be treated like Priority 4 species in those parts of the state where they were known to be common (the instruction manual described these regions), and like Priority 2 species where they were thought to be absent. For Priority 4 species we asked that just one record card be submitted for each town in which the species was recorded, and only once during the 5-year duration of MARAP. The priority system worked for some

participants and not for others. Some people sent in multiple reports for common species, or failed to telephone about rare ones. Other people followed instructions assiduously.

We used Maine's 912 towns and townships as the basis for our record keeping because (1) they are quite uniform in area (most are close to 36 square miles [93 km<sup>2</sup>]); and (2) they are easy for participants to use. If we had used units based on latitude and longitude (e.g., 7.5' blocks) they would have been of more uniform size, but participants would have needed a USGS map of each area they visited. To determine if water barriers or watershed lines might coincide with the limits of species' distributions we asked for separate records for coastal islands and different sections of towns that were divided by major rivers and watershed lines. We did not receive enough records at this smaller scale to be useful. Knowing that several participants had been keeping accurate records of their herp observations we encouraged submission of records from 1970–1983 and received 204. Our attempt to encourage submission of negative records (areas thoroughly searched without success) was not very fruitful.

We used a record card, reproduced below, that asked for 22 items of information, but only six of these proved to be important. These were (1) name of species, (2) date, (3) name of recorder, (4) township, (5) the type of record (specimen collected, photograph taken, specimen handled and released, specimen seen or heard but not captured), and (6) the degree of confidence of the observer that their observation was correct (most records were 99 or 100% confident, but this feature allowed us to eliminate some doubtful records). Further details on the exact location, and directions for finding it, were sometimes useful for high-priority species.

Side 1

MARAP RECORD CARD		DATE: _____
complete both sides		TIME: _____
SPECIES: _____	RECORDER: _____	
TOWNSHIP: _____	COUNTY: _____	
VERIFICATION: _____	% CONFIDENCE: _____	
LOCATION: _____		
DIRECTIONS (Priority 1 and 2 species): _____		
_____		
_____		
_____		

Side 2:

BEHAVIOR: _____	AGE: _____	SEX: _____
HABITAT: _____		
MICROHABITAT: _____		
TERRESTRIAL HABITAT: _____	DISTANCE: _____	
AQUATIC HABITAT: _____	DISTANCE: _____	
WEATHER: _____	INDIVIDUALS: _____	
OTHER NOTES: _____		
_____		
_____		
RETURN TO: MARAP		
c/o Maine Audubon		
118 U.S. Route 1		
Falmouth, ME 04105		

We asked for many additional items (e.g., distance to the nearest aquatic habitat for terrestrial records), but did not find them useful as a source of information for writing this book. They may have served a purpose in making the project more interesting for some participants.

At the end of each field season we distributed a short newsletter highlighting the most important discoveries of the year and reminding participants to submit their cards. During the winter we collated data and at the beginning of each season we mailed out maps showing all the records to date. From these we made specific suggestions for future searches; e.g., "We have records of water snakes from western Penobscot County and eastern Washington County and would like to know if they really are absent from the area between these sites."

Specimens and photographs collected during the project are being prepared for submission to the Museum of Comparative Zoology at Harvard University by Carroll Knox, and a list of records with museum numbers will be available from Mac Hunter. Collecting these materials from the participants and curating them proved to be a major difficulty and many specimens were lost in the process.

Frustrated by the scarcity of records for our rarest species, we produced and distributed a large WANTED poster depicting a racer, box turtle, spotted turtle, and Blanding's turtle and asking people to call in with information about sightings of these species. The poster did not generate many reports, but it led us to some important records and confirmed our suspicion that these species are rare in Maine.

## THE DISTRIBUTION AND ABUNDANCE OF AMPHIBIANS AND REPTILES IN MAINE

The science of ecology has been stretched and pulled in many directions, particularly because the environmental movement has given the word "ecology" widespread appeal. At its foundation, however, ecology is the science that seeks to understand how organisms interact with their environment and how the outcome of these interactions is manifested in the distribution and abundance of organisms. Although the MARAP effort was not a systematic survey of Maine's amphibians and reptiles, some important insights into patterns of distribution and abundance can be gleaned by studying the range maps.

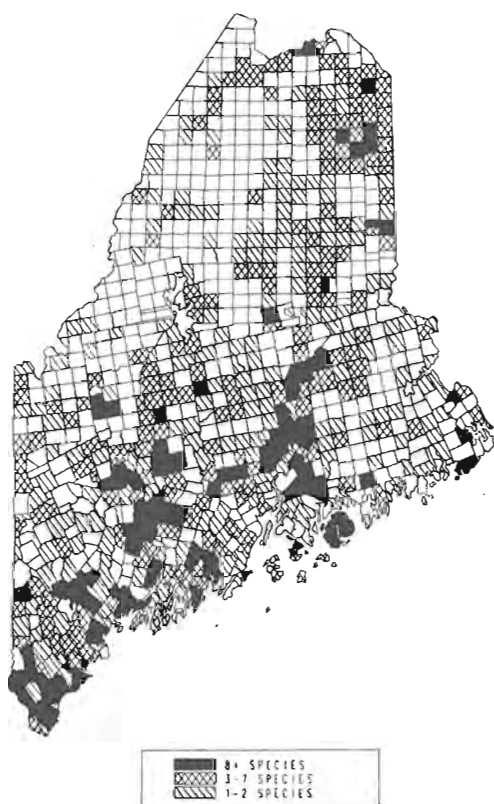
The most obvious pattern is the absence of many species from northern Maine. Among the 16 species of reptiles (excluding the marine turtles and extirpated rattlesnake) it is possible that only the garter snake and wood turtle are found throughout the state. Of course, this general pattern is widespread because reptiles are ectothermic ("cold-blooded" in common parlance) and the climate becomes colder as one moves towards the poles. The sharpness of the change—from 16 species in southern Maine to 2–6 species in northern Maine, a distance of about 450 kilometers (270 miles)—is probably due to the steep climate gradient discussed in the section entitled "Maine's Environment as Habitat for Amphibians and Reptiles." To reiterate briefly, latitude, altitude, and distance from the ameliorating effect of the ocean, all combine to change the frost-free period from 160 days along the coast of southwestern Maine to 90 days throughout northwestern Maine. The snapping turtle, green snake, redbelly snake, and ringneck snake may also occur statewide. The snapping turtle is found in northeastern Maine and may occur in the northwest too. The three snake species have been recorded from parts of Canada near northern Maine. Altitude and distance from the coast may explain why green, redbelly, and ringneck snakes may be absent from northern Maine, yet occur in nearby Quebec and New Brunswick, because along the shores of the St. Lawrence River and Gulf of St. Lawrence the climate is warmer than in northern Maine.

Amphibians are often better adapted to cold climates than reptiles and among Maine's 17 native species, there may be only two to four species that reach their northern range limit in Maine. The gray treefrog and spring salamander are almost certainly absent from all of northern Maine. Four-toed salamanders are probably absent, but they are so hard to find it is difficult to be confident about their absence. Bullfrogs are likely to be absent from the very coldest parts of northwestern Maine. This is a much smaller percentage of species reaching their northern range limits (12–24%) than for reptiles (62–88%), and closer to the equivalent figures for Maine's woody plants (54 of 240 species or 22%; McMahon et al. 1990) or breeding birds (29–37 of 201 species, or 14–18%; Adamus no date). Looking at the rangewide



maps for amphibians most Maine species reach their northern limits in Quebec, well north of the St. Lawrence.

One might ask to what extent is the apparent distribution of herps affected by the distribution of MARAP participants, most of whom live in southwestern Maine. The figure below shows that there are some parts of the state with few records, but fortunately northeastern Maine is not one of them. MARAP's single most productive participant, Carroll Knox, lives in Caribou and his failure to find gray treefrogs, spring and four-toed salamanders, and redbelly, green, and ringneck snakes during the five years of MARAP and the 45 years he has been studying the herps of northern Maine means that they are probably absent from this area.



Overall distribution of MARAP records. Solid shading indicates towns with eight or more species reported, cross-hatching indicates towns with 3-7 species reported, and diagonal lines indicate towns with 1-2 species reported.

MARAP was not designed to estimate the population sizes of various herps, but one can reach some tentative estimates about their relative commonness using the number of towns for which records were submitted for each species, if the relative detectability of each species is taken into account. In other words, one must consider a species' behavior and how frequently people visit its habitat. For example, the three species of salamander that live under streamside rocks are equally detectable and the number of records of each (two-lined—113, dusky—44, and spring—16) is a rough indication of their relative abundance. On the other hand, it would be a mistake to assume that wood frogs (168 towns), spring peepers (167), American toads (142), and green frogs (138) occur in this order of abundance because these species are usually detected in breeding groups and whatever the size of the group only one record would be submitted. It might be reasonable to say that these four anurans are probably more common than bullfrogs (104), pickerel frogs (59), gray treefrogs (51), mink frogs (48), and leopard frogs (40).

Generally this method of estimating abundance is likely to underestimate common species and overestimate uncommon species because only one record per town was used, and because MARAP participants were probably more diligent about recording their encounters with uncommon species. This is particularly true for the species listed by the Dept. of Inland Fisheries and Wildlife as being of conservation concern: Blanding's, box, spotted, and wood turtles, black racer, ribbon snake, and brown snake.

Among the salamanders that live subterranean lives, spotted salamanders (115) seem more common than blue-spotted salamanders (65), but because these two species make conspicuous movements to their spring breeding pools they cannot be readily compared to redbacks (88) and four-toeds (11). Although redback salamanders only have a moderate number of records, direct estimates of their abundance indicate they are the most abundant vertebrate animal in the state (Witham, this volume). The four-toed salamander may be Maine's least conspicuous amphibian, but it is also likely that it is quite uncommon too.

Among the turtles, the basking habit of painted turtles (95) no doubt contributes to their high number of records; they may well be less common than the more aquatic snapping turtles (88). Although the musk turtle (18) only has a few more records than the spotted (13) or Blanding's (6) turtles, it is generally more aquatic and more nocturnal and thus less conspicuous. The wood turtle (49) is almost certainly more common than our other primarily terrestrial turtle, the box turtle (6).

The garter snake (160) is no doubt the most abundant reptile, with its statewide distribution and broad tastes in habitat. Among the three small, often subterranean snakes, the redbelly (61) appears to be more common than ringnecks (24) or brown snakes (11). Among the snakes associated with early successional ecosystems, black racers (8) are much rarer than milk snakes (39) and green snakes (51). In aquatic habitats water snakes (22) are

probably more common than ribbon snakes (7), although ribbon snakes can be hard to distinguish from garter snakes.

The relative abundances estimated here refer to the likely total numbers of each species in Maine rather than their relative density within those parts of Maine where they occur. This can be an important distinction when comparing two species with very different ranges. For example, while there were roughly eight times as many records for wood turtles as box turtles, this difference must be partly due to the statewide distribution of the wood turtle compared to the box turtle's limited distribution. In other words, both species may occur at fairly low densities but the wood turtle has a greater total population because of its greater range.

One overall pattern is quite clear. Although the first listing by the Maine Department of Inland Fisheries and Wildlife of species deserving special conservation consideration was based on just one year of MARAP data, the decisions continue to appear basically sound after five years of searching for Maine herps. Certainly, however, as our knowledge grows, some fine-tuning of the list will be needed. We can hope that the changes will be to remove species from the list because they are secure, rather than to add more species discovered to be in trouble.



## CONSERVATION OF MAINE'S AMPHIBIANS AND REPTILES

Maine's amphibian and reptile fauna is an important biological resource that has been neglected for too long. For many years these species were perceived to have little economic or ecological importance and were regarded, at best, as curious evolutionary relics. They have been misunderstood by the public and politicians and, until recently, ignored by resource managers. As a result, there has been little financial support for herpetological research and conservation. Ecological awareness is increasing, however, and a more positive attitude towards Maine's amphibians and reptiles seems to be evolving. In the mid-1980's, establishment of Maine's Rare and Endangered Species List and the MARAP effort greatly increased public and political awareness for the conservation of these species. We have only begun to understand these fascinating creatures, and everyone can make a lasting contribution to their preservation.

**THREATS:** Amphibians may serve as a vital indicator of the health of the global environment. They require both aquatic and terrestrial environments, the young feed at the base of the food chain and the adults feed at the top, and because of their thin epidermis, they are particularly sensitive to changes in their chemical and physical environment. In 1990, an international group of herpetologists first announced disturbing news that populations of amphibians were experiencing unexplained, worldwide declines (Wyman 1990). Declines were even reported in pristine environments. Scientists could not develop a unifying theory for this phenomenon, but deterioration of the ozone layer and increased ultraviolet radiation, habitat degradation, and acid rain were all proposed as culprits. Twelve amphibian species in the Northeast, especially those on the edge of their range, showed evidence of range reduction or population declines. Recent studies suggest that acid precipitation could be particularly injurious to amphibians (especially salamanders) inhabiting areas with acidic forest soils, particularly coniferous forests which occupy much of Maine (Wyman 1988).

Habitat fragmentation is of great concern in southern Maine, the state's area of greatest amphibian and reptile diversity and the range of Maine's four endangered and threatened reptile species. Residential development is occurring at an alarming rate in York and Cumberland counties, where the human population has increased by 58% between 1960 and 1990. Roads and suburban development carve the landscape into ever smaller parcels of habitat. Over time, populations become isolated and have a greater chance of becoming extinct. Roads create barriers to reptiles and amphibians traveling between wetlands and prevent genetic interchange among populations. Roads traffic also causes tremendous mortality, especially during the mating and nesting seasons.

The effects of harvesting on species that have an economic value (e.g., snapping turtles or bullfrogs as food, or wood turtles as pets) is unknown. For turtles, mortality of eggs and young is exceptionally great, and survival of adults may be critical to the perpetuation of a population. Removing too many adult turtles may cause the population to decline or disappear. We simply know too little about the population dynamics of reptile and amphibian populations to understand if indeed there is a "harvestable surplus."

Finally, introductions of reptiles and amphibians may be injurious to local populations. Fortunately, Maine's environment is too hostile for the survival of most exotic species (such as a boa constrictor found in Portland!). However, at least one new species has become established (mudpuppies in the Belgrade Lakes), and a sizable, although unknown, number of herps are brought in every year by the pet trade. Perhaps more important, millions of tourists visit Maine annually and no doubt a fair number of them bring amphibians and reptiles that they no longer want to keep so that they can release them "in a good home." Painted turtles are believed to have been introduced to Mt. Desert and Matinicus Islands. Exotic species such as a three-toed box turtle, diamond-backed rattlesnake and red-eared turtle have been recorded in the state. Released amphibians and reptiles may interbreed with native animals contributing maladaptive genes to the local populations. Similarly, they may introduce injurious diseases or parasites.

**LAWS PROTECTING MAINE AMPHIBIANS AND REPTILES:** Maine law provides only minimal protection for reptiles and amphibians. According to Maine statute, the Maine Department of Inland Fisheries and Wildlife is charged to "preserve, protect and enhance the wildlife resources of the state, encourage the wise use of these resources; to ensure coordinated planning for the future use and preservation of these resources; and provide for the effective management of these resources." "Wildlife" is defined to include amphibians and reptiles and all members of the animal kingdom. However, most laws were written to protect only "wild birds or animals" which by definition excludes reptiles and amphibians. A permit is required to import any reptile or amphibian into the state. A permit is also needed to collect snapping turtles, but there are no limits on when, where, or how many are collected. In general, Maine law does not protect nonendangered or threatened reptiles and amphibians from harassment, taking (collecting), or possession. The Maine Endangered Species Act is more far-reaching and strictly prohibits exporting, hunting, trapping, selling, transporting, feeding, baiting, or harassing any Endangered or Threatened species of amphibian or reptile.

Maine is one of the few remaining states with legal loopholes allowing the unrestricted commercial collection of amphibians and reptiles. In 1991, "hundreds" of wood turtles for sale in Florida were reputed to have been collected "legally" in Maine for the pet trade. Considering the scarcity of wood turtle sightings in MARAP this was unlikely, and it was suspected that

unscrupulous collectors were illegally collecting turtles in other states under the guise that they came from Maine. We anticipate that serious oversights in Maine laws protecting amphibians and reptiles will be corrected by laws proposed in 1992 and commercial collection of all species except snapping turtles will be forbidden. Similar efforts are underway to tighten restrictions in all Northeastern states.

**RARE AND ENDANGERED SPECIES:** Except for marine turtles, none of Maine's amphibians or reptiles are on the U. S. Fish and Wildlife Service's Endangered Species List. However, Maine Department of Inland Fisheries and wildlife adopted a state List of Rare and Endangered Species in 1986. The black racer and the box turtle were declared Endangered because of their extreme rarity. Historic evidence suggests they have been present in the state for centuries. Despite new MARAP records, their status, life history, and habitat requirements remain an enigma. The Blanding's turtle and spotted turtle are on the Threatened list. Both of these aquatic turtles could easily become endangered because of their regional rarity, localized, small populations, and threats to wetland habitat within their range. The ribbon snake (Special Concern List), brown snake, and wood turtle (Indeterminate Status) may be vulnerable to extirpation, but insufficient data exists to classify them as Endangered or Threatened. Maine may hold the dubious distinction as the only state in New England to successfully extirpate the timber rattlesnake although more searching is needed to establish its true status in this and other New England states. The timber rattlesnake populations have declined dramatically throughout much of the region from overharvesting and habitat loss. There are current proposals to list the New England population as Endangered or Threatened under the Federal Endangered Species Act.

Recovery plans are being developed for all Maine Endangered and Threatened Species, and the sites where they are documented are now eligible for stringent habitat protection measures. Endangered species status heightened public awareness of reptiles and amphibians and resulted in state-financed initiatives for their recovery. A study of the habitat needs and life history of Maine's spotted and Blanding's turtles is now underway at the University of Maine. Also, key wetlands for these species near Mt. Agamenticus have been purchased by the Lands for Maine's Future Fund. The Nature Conservancy and Land for Maine's Future Fund have contributed greatly to the conservation of racers by purchasing the Kennebunk Plains, the site of at least 16 racer sightings in the last decade, now managed by the Maine Department of Inland Fisheries and Wildlife.

**FUTURE CONSERVATION NEEDS:** Conservation of Maine's reptiles and amphibians is in its infancy. However, major conservation efforts will likely have to wait until there is a marked improvement in awareness of amphibians and reptiles by the general public, resource managers, and

political officials (Gibbons 1988). Education is the key. MARAP and the Maine Endangered Species Project have initiated the process. It is important that herp enthusiasts, scientists, and managers inform the public and politicians that an understanding of amphibians, reptiles, and other inconspicuous nongame species are vital to proper ecosystem management.

MARAP provides the baseline data by which the status and distribution of our amphibian and reptile fauna will be assessed. Much of the MARAP data has already been incorporated into habitat protection measures, especially for the rarest species. However, the importance of continued survey and monitoring are paramount, especially in light of apparent worldwide declines in many of these species. Additional surveys are needed to obtain baseline population data and must be duplicated regularly to assess long-term trends in amphibian and reptile distribution and abundance. A few states have initiated amphibian census routes, similar in concept to breeding bird surveys. Permanent routes are established and singing frogs or migrating salamanders are counted annually.

You can personally contribute to the conservation of reptiles and amphibians by recording your observations of reptiles and amphibians, particularly of the rarest species. There still remains the opportunity to discover the presence of new species in the state or to document major range extensions. Send your observations to the Endangered and Nongame Wildlife Fund, Maine Department of Inland Fisheries and Wildlife, P. O. Box 1298, Bangor, ME 04402-1298.

Basic life history information is not available for most of our reptiles and amphibians and efforts to acquire this information have lagged far behind other vertebrate groups. As an example, fewer than 2% of the scientific articles published in recent volumes of the major natural history journals dealt with amphibians and reptiles (Gibbons 1988). Funding for such studies should increase as public concern towards amphibians and reptiles increases. Management decisions will be difficult without information on population size and characteristics, habitat needs, and basic life history information.

In addition to basic research on life history and ecology, studies on the effects of large-scale landscape changes on reptile and amphibian communities are necessary. The effects of habitat fragmentation in southern Maine, wetland alteration and pollution, and the influence of logging practices, stand conversion to softwoods, and application of pesticides and herbicides warrant intensive research. Studying how to design ecological reserves for amphibian and reptile communities is particularly important.

Maine Inland Fisheries and Wildlife must enforce regulations affecting the taking of amphibians and reptiles and protection of their habitats. There is a real danger that some of the information in this book could be used by unscrupulous collectors to illegally take Maine reptiles for sale in the pet trade. You can help by reporting illegal collecting of reptile and amphibians or violations of habitat protection laws to the Warden Service.

Most of Maine's amphibians and reptiles depend on wetlands for their continued survival. By some estimates, about one third of Maine is considered wetlands, but our state has lost 20% of its wetlands since colonial times (Dahl 1990). State and federal regulations protect most wetlands and some upland habitats, particularly for Threatened and Endangered species. However, Maine's current statutes generally protect only wetlands greater than 10 acres. The myriad of small wetlands, including vernal pools, that are so critical to the continued survival of Maine's amphibians and some reptiles were protected by the federal Clean Water Act, as enforced in Maine by the Army Corps of Engineers and the Environmental Protection Agency. However, in 1991, an Executive policy for "no net loss" of wetlands was reversed by President Bush, who claimed that "a small pothole in your backyard is not a wetland." Because of the inconsistency of federal wetland policy, it would be prudent for Maine to develop a more comprehensive review of the value of small wetlands and consider their protection. Some states, like Massachusetts, have recognized the importance of small wetlands to the continued existence of amphibians and have instituted programs to register and protect vernal pools.

Finally, we need conservation strategies for reptiles and amphibians. We should study the feasibility of reintroducing extirpated species, even controversial ones like the timber rattlesnake. We should challenge public and private groups to create the first Maine reserve specifically for the study and conservation of reptiles and amphibians. For example, The Nature Conservancy in Vermont recently established a 1,000 acre reserve to protect one of the state's last timber rattlesnake populations. We should insist that the management and protection of reptiles and amphibians be addressed on all of Maine's public lands and incorporated into management plans. Projects to protect migrating amphibians from automobile mortality have received much attention in Great Britain, California, and Amherst, Massachusetts. The "toad tunnels" and salamander crossing signs serve a useful management function, and also raise public awareness.

As we approach the twenty-first century, federal and state fish and wildlife agencies, including Maine, are embracing the realization that wildlife conservation will have to encompass all animals and plants and the ecosystems upon which they depend. There are encouraging signs that reptiles and amphibians will be among the first taxonomic groups to benefit from this enlightened philosophy. Still, public education is necessary to pave the way for these advances. It is unfortunate that we don't have more faith in the Native American belief that the earth and all life was created as the crust on the back of a giant turtle. Had this philosophy prevailed, an environmental ethic for the conservation of reptiles and amphibians would surely have been initiated long ago.

Mark McCollough, Endangered and Nongame Wildlife Fund, Maine Department of Inland Fisheries and Wildlife



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## GLOSSARY

amplexus	the position assumed by male and female frogs during egg laying and external fertilization; the male is on the female's back, clasping her under her forelegs.
anterior	referring to the front or snout end of an animal
carapace	the top shell of a turtle
cloaca	chamber into which the intestinal, urinary, and reproductive tracts open
costal grooves	vertical grooves on the sides of a salamander
distal	away from the body; outward
dorsum (dorsal)	the top or back of an animal
keeled scales	snake scales with a distinct ridge across the middle
lateral	referring to the sides of an animal
oviparous	producing eggs
oviposit	to lay eggs
posterior	referring to the tail end of an animal
plastron	the bottom shell of a turtle
proximal	toward the body, inward
scutes	the plates of a turtle's shell
smooth scales	snake scales without a ridge
tympanum	eardrum, most frogs and toads have a large external one
venter (ventral)	the bottom or abdomen side of an animal
vent	external opening into the cloaca
viviparous	producing live young (Most reptiles are actually ovoviviparous because the young are produced in an egg, then the egg hatches within the mother's body.)

## WANTED: MORE INFORMATION ABOUT MAINE'S AMPHIBIANS AND REPTILES

Are hognose snakes, marbled salamanders, or Fowler's toads yet to be discovered in Maine? Are timber rattlesnakes waiting to be rediscovered? Just how rare are Blanding's, wood, box, and spotted turtles, black racers, ribbon and brown snakes? Are four-toed and springsalamanders, gray treefrogs, ring-neck, green, and red-bellied snakes found in northern Maine?

Although the Maine Amphibian and Reptile Project officially ended in 1988, there is still much to be learned about our herpetofauna and the readers of this book can help. The Endangered and Threatened Species Program of the Maine Department of Inland Fisheries and Wildlife will continue to track occurrences of Maine's reptiles and amphibians and solicits your observations of rare or new species. If you find a rare species or a species not previously noted in an area according to the range maps, please photocopy this page, fill out the form below, and send your observations to the Endangered and Threatened Species Program at the address below. For the rare species listed above, please photograph your specimen whenever possible before releasing it where it was found; then send your photograph to us as well. Your information will be used to update the range maps, to further our knowledge of these species, and to aid in their conservation.

MARAP RECORD CARD		DATE: _____
SPECIES: _____	RECORDER: _____	
TOWNSHIP: _____	COUNTY: _____	
VERIFICATION: _____	% CONFIDENCE: _____	
(Photo/Handled/Seen)		
LOCATION (be as specific as possible): _____		
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OTHER NOTES (Habitat, Behavior, Age, Sex): _____
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RETURN TO:      MARAP, Endangered and Threatened Species Program, Maine Department of Inland Fisheries and Wildlife, PO Box 1298, Bangor, ME 04402-1298